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ABSTRACT

This volume is the second of four volumes that comprise a curriculum guide for a postsecondary industrial maintenance program. It contains part of section 3 of the guide which contains the unit guides for two of the 12 duties included in the course. Each of the 197 tasks included in these two duties is presented on a separate page and contains the following information: task, performance objective, instructional materials, evaluation, and class and lab hours. Topics covered are industrial process and maintenance and electrical maintenance. (YLB)

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# INDUSTRIAL MAINTENANCE

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## VOLUME II-A

## CURRICULUM GUIDE

Georgia Department of Education

# INDUSTRIAL MAINTENANCE

Developed Under Contractual Agreement with

Division of Program Development
Office of Vocational Education
Georgia Department of Education
Atlanta, Georgia 30334
Charles McDaniel, State Superintendent of Schools
1981

# INDUSTRIAL MAINTENANCE

## VOLUME II-A

Developed by

The University of Georgia

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## INDUSTRIAL MAINTENANCE - VOLUME II-A

## TABLE OF CONTENTS

SECTION III: UNIT GUIDES (Gold)..............................III-1
Unit Guide Description.................................III-5
Industrial Maintenance Task Index......................III-7
Unit Guides...........................................III-19

# SECTION III

## UNIT GUIDES

# SECTION III

## Section III Content List

Unit Guide Description
Suggested Sequence of Unit Guides

In Section II, the relationship between the occupational area and program tasks was introduced. Section III continues this development by presenting, for each task, a unit guide for instructional planning and execution.

The instruction of specific tasks is central to vocational education. However, the value of a single task/competency to the student as a prospective member of the workforce is dependent upon the way in which that task/competency is related to other tasks and to the entire occupational area. Therefore, the Industrial Maintenance Program Task Listing provides a sample organizational model for sequencing the instruction of program tasks.

# UNIT GUIDES DESCRIPTION

In this section the tasks to be taught in each course are presented in sequential order. Each task is listed on a separate page so that it may be taken out of the guide for daily lesson planning or regrouped with order tasks to fit the individual teacher's preference for teaching order. The task pages may be used for planning and executing group instruction or for individualized instruction. Each page in the UNIT GUIDES section contains the following information:

TASK: This is a short and concise statement of the task to be taught.

PERFORMANCE OBJECTIVE: The performance expected of the student after completing the unit is stated in stem form, without a specific statement of all conditions, equipment and performance standard (these are listed in a criterion referenced measure in the Evaluation section of the task page).

INSTRUCTIONAL ACTIVITIES: Suggested learning activities are presented. These activities include providing information, demonstration, practical applications and projects.

INSTRUCTIONAL MATERIALS: Suggested materials for carrying out the instructional activities are listed. These include textbooks, audiovisuals and equipment. Textbooks are referenced by author and title with the complete reference contained in the textbook list in the Instructional Resources section.

EVALUATION: This section contains a criterion referenced measure and reference to any test items or other evaluation measures that are available to teacher.

CLASS/LAB HOURS: The estimated time for completion of the instructional activities and the evaluation are indicated in both classroom and lab hours. Total instructional time would be the sum of these.

# INDUSTRIAL MAINTENANCE TASK INDEX

## DUTY I: Industrial Process and Maintenance

Page No.

IPM-01 Identifying basic principles of blueprint reading.......19
IPM-02 Identifying elements of machine drawings.......21
IPM-03 Identifying hydraulic and pneumatic drawings.......23
IPM-04 Using machine drawings in the maintenance of machinery and equipment.......25
IPM-05 Reading building drawings.......27
IPM-06 Reading electrical drawings.......29
IPM-07 Reading pipe system drawings.......31
IPM-08 Reading sheet metal drawings.......33
IPM-09 Using shop math to interpret blueprints.......35
IPM-10 Sketching schematic diagrams.......37
IPM-11 Identifying types of schematics used in plant engineering.......39
IPM-12 Identifying the symbols on electrical, piping and fluid power diagrams.......41
IPM-13 Identifying guidelines for reading schematics.......43
IPM-14 Identifying electrical symbols.......45
IPM-15 Reading electrical diagrams.......47
IPM-16 Identifying piping symbols.......49
IPM-17 Reading piping schematics.......51
IPM-18 Identifying fluid power symbols.......53
IPM-19 Reading fluid power schematics.......55
IPM-20 Identifying welding symbols.......57
IPM-21 Identifying and using basic measuring tools.......59
IPM-22 Identifying and using wrenches and screwdrivers.......61
IPM-23 Identifying and using pipefitting tools.......63
IPM-24 Identifying and using plumbing tools.......65
IPM-25 Identifying and using electrical tools.......67
IPM-26 Identifying and using cement, plaster and glazing tools.......69
IPM-27 Identifying and using woodworking tools.......71
IPM-28 Identifying and using sheet metal tools.......73
IPM-29 Identifying and using metalworking tools.......75
IPM-30 Identifying and using hoisting and pulling tools.......77
IPM-31 Identifying plant safety procedures.......79
IPM-32 Observing safety precautions for tools and equipment.......81
IPM-33 Identifying machinery safeguards.......83
IPM-34 Observing safety in handling materials.......85
IPM-35 Identifying work area safety precautions.......87
IPM-36 Identifying fire prevention procedures.......89
IPM-37 Handling hazardous materials.......91
IPM-38 Observing electrical safety precautions.......93
IPM-39 Identifying personal protection gear.......95

Page
No.

IPM-40 Identifying basic principles of lubrication....97
IPM-41 Identifying characteristics of lubricants....99
IPM-42 Identifying additives, lubricating action and bearing lubrication....101
IPM-43 Identifying oils and their applications....103
IPM-44 Identifying general purpose greases....105
IPM-45 Identifying special purpose greases....107
IPM-46 Identifying lubricating compounds....109
IPM-47 Identifying lubrication systems and methods....111
IPM-48 Identifying automatic lubrication methods....113
IPM-49 Identifying methods of lubricant storage and handling....115
IPM-50 Identifying common couplings....117
IPM-51 Identifying special couplings....119
IPM-52 Identifying clutches....121
IPM-53 Identifying V-belt drives....123
IPM-54 Identifying chain drives....125
IPM-55 Identifying speed reducers....127
IPM-56 Identifying gears....129
IPM-57 Identifying variable speed reducers....131
IPM-58 Identifying brakes and motors....133
IPM-59 Identifying principles of bearings and shafts....135
IPM-60 Identifying plain journal bearings....137
IPM-61 Identifying anti-friction bearings....139
IPM-62 Identifying ball and roller bearings....141
IPM-63 Identifying specialized bearings....143
IPM-64 Identifying bearing seals....145
IPM-65 Identifying methods of bearing lubrication....147
IPM-66 Maintaining bearings....149
IPM-67 Identifying pump application....151
IPM-68 Selecting a pump....153
IPM-69 Identifying centrifugal pumps....155
IPM-70 Identifying propeller and turbine pumps....157
IPM-71 Identifying rotary pumps....159
IPM-72 Identifying reciprocating pumps....161
IPM-73 Identifying metering pumps....163
IPM-74 Identifying special purpose pumps....165
IPM-75 Installing packings and maintaining pump seals....167
IPM-76 Performing pump maintenance....169
IPM-77 Identifying piping systems and piping system maintenance....171
IPM-78 Maintaining metal pipe....173
IPM-79 Maintaining non-metallic piping....175
IPM-80 Maintaining tubing....177
IPM-81 Maintaining hoses....179
IPM-82 Maintaining fittings....181
IPM-83 Maintaining common valves....183

Page
No.

IPM-84 Identifying specialized valves....................185
IPM-85 Maintaining strainers, filters and traps..........187
IPM-86 Maintaining pipeline by monitoring accessories.................................189
IPM-87 Identifying principles of hydraulics..............191
IPM-88 Identifying hydraulic fluids......................193
IPM-89 Identifying strainers and filters in hydraulic systems..............................195
IPM-90 Identifying reservoirs and accumulators in a hydraulic system...........................197
IPM-91 Identifying hydraulic pumps on a system...........199
IPM-92 Identifying piping, tubing and fittings...........201
IPM-93 Identifying directional control valves............203
IPM-94 Identifying pressure control valves...............205
IPM-95 Identifying cylinders in a hydraulic system.......207
IPM-96 Identifying hydraulic motors......................209
IPM-97 Troubleshooting hydraulic systems using schematics...................................211
IPM-98 Reading hydraulic schematic diagrams..............213
IPM-99 Installing hydraulic components...................215
IPM-100 Installing pipes and tubes........................217
IPM-101 Selecting hydraulic fluids........................219
IPM-102 Planning system maintenance......................221
IPM-103 Troubleshooting hydraulic systems (diagnostic techniques)........................223
IPM-104 Troubleshooting valves............................225
IPM-105 Troubleshooting cylinders.........................227
IPM-106 Troubleshoot pumps and motors.....................229
IPM-107 Identifying pneumatic principles..................231
IPM-108 Identifying reciprocating compressors.............233
IPM-109 Identifying rotary compressors....................235
IPM-110 Identifying primary air treatment in pneumatic systems..............................237
IPM-111 Identifying secondary air treatment methods......................................239
IPM-112 Identifying piping, hoses and fittings used in pneumatic systems......................241
IPM-113 Identifying control valves........................243
IPM-114 Identifying pressure relief valves................245
IPM-115 Identifying cylinders.............................247
IPM-116 Identifying motors................................249
IPM-117 Identifying components of pneumatic systems.........................................251
IPM-118 Reading pneumatic schematic diagrams..............253
IPM-119 Installing system components......................255
IPM-120 Identifying procedures for pneumatic system maintenance.............................257
IPM-121 Determining system failures.......................259
IPM-122 Troubleshooting air compressors...................261
IPM-123 Troubleshooting control valves....................263
IPM-124 Troubleshooting cylinders.........................265
IPM-125 Troubleshooting air motors........................267
IPM-126 Troubleshooting pneumatic and hydraulic systems.....................................269

DUTY II: Electrical Maintenance — Page No.

EL-01 Identifying basic electrical theory................271
EL-02 Determining transformer polarity..................273
EL-03 Connecting to and operating dual voltage single phase transformers........................275
EL-04 Connecting single phase transformers in series....................................277
EL-05 Connecting single phase transformers in parallel..................................279
EL-06 Determining the KVA rating of single phase transformers...........................281
EL-07 Determining the KVA rating of three phase transformers...........................283
EL-08 Hooking up and operating a one phase auto transformer...............................285
EL-09 Hooking up a one phase buck booster transformer....................................287
EL-10 Hooking up a three phase transformer..............289
EL-11 Hooking up a three phase auto transformer.........291
EL-12 Hooking up a three phase transformer bank connected Wye/Wye..........................293
EL-13 Hooking up a three phase transformer bank connected Delta/Delta......................295
EL-14 Hooking up a three phase bank of transformers open Delta.........................297
EL-15 Hooking up a three phase transformer bank connected Wye/Delta........................299
EL-16 Hooking up a three phase transformer bank connected Delta/Wye........................301
EL-17 Hooking up a three phase transformer bank; reversed voltage..........................303
EL-18 Hooking up transformers for special applications.....................................305
EL-19 Calculating service load for a small commercial building.............................307
EL-20 Locating service entrance equipment and writing specifications.........................309
EL-21 Selecting a service entrance conductor............311
EL-22 Calculating service conduits......................313
EL-23 Installing service conduits.......................315
EL-24 Installing service entrance conductors............317
EL-25 Selecting and installing meters...................319
EL-26 Selecting and installing panels...................321
EL-27 Calculating and installing motor branch circuits.........................................323
EL-28 Installing and operating subfeeders and panels...........................................325
EL-29 Grouping outlets onto branch circuits.............327
EL-30 Installing specific purpose outlets...............329
EL-31 Calculating branch circuit conductors and overcurrent protection..........................331
EL-32 Installing branch circuits and controls for lighting.....................................333
EL-33 Selecting conduit.................................335
EL-34 Installing conduit under a concrete slab..........337

Page No.

EL-35 Installing outlet, junction and conduitlets....................................339
EL-36 Installing branch circuits and controls for air conditioning and heating................341
EL-37 Selecting and installing branch circuits for three phase water heaters..................343
EL-38 Planning and performing site work for a small industrial facility........................345
EL-39 Making calculations for electric motors, welders and heaters...........................347
EL-40 Calculating the 120 and 277 volt lighting load............................................349
EL-41 Calculating and selecting receptacles for 120/208 volt loads..............................351
EL-42 Calculating size for and selecting and installing a Bass-Duct..........................353
EL-43 Selecting and installing a three phase, four wire 480v panel............................355
EL-44 Selecting the correct transformer bank............357
EL-45 Selecting and installing a 480v/280-120 three phase four wire service...................359
EL-46 Installing metering equipment.....................361
EL-47 Selecting and installing panels and selecting distribution equipment................363
EL-48 Selecting and installing a 277v flourescent light............................................365
EL-49 Determining sizes and types of feeders and overcurrent protection devices..............367
EL-50 Installing a branch circuit for welders...........369
EL-51 Operating a split phase motor.....................371
EL-52 Operating a capacitor start motor.................373
EL-53 Operating a universal motor.......................375
EL-54 Operating a three phase induction motor...........377
EL-55 Operating a three phase synchronous motor.........379
EL-56 Operating a three phase, one winding, two speed motor............................................381
EL-57 Operating a three phase, two winding, two speed motor............................................383
EL-58 Operating single and three phase alternators......385
EL-59 Operating an induction regulator..................387
EL-60 Operating a rotary frequency changer..............389
EL-61 Operating a synchronous rotary converter..........391
EL-62 Operating a rotary converter......................393
EL-63 Operating DC motors...............................395
EL-64 Operating and checking load characteristics of DC generators...................................397
EL-65 Correcting power factors..........................399
EL-66 Hooking up and operating gear motors.............401
EL-67 Selecting correct machine drive...................403
EL-68 Installing ventilator fans........................405
EL-69 Identifying motor leads..........................407
EL-70 Identifying hazardous wiring locations............409
EL-71 Operating a power actuated tool..................411

## DUTY III: Machine Shop

Page No.

MS-01 Laying out metal surfaces..........413
MS-02 Identifying jig buttons..........415
MS-03 Using the sine bar..........417
MS-04 Using the bevel protractor..........419
MS-05 Using steel rules..........421
MS-06 Using the micrometer..........423
MS-07 Reading a vernier scale..........425
MS-08 Using dial indicators, center testers and speed indicators..........427
MS-09 Using precision gage blocks, tapered ring, plug and snap gages..........429
MS-10 Identifying and using hand hacksaws..........431
MS-11 Using abrasives and lapping compounds..........433
MS-12 Identifying and using files..........435
MS-13 Scraping flat and curved bearing surfaces..........437
MS-14 Using hammers and screwdrivers for hand bench use..........439
MS-15 Identifying and using wrenches..........441
MS-16 Using bench vises and clamps..........443
MS-17 Identifying and using chipping tools..........445
MS-18 Using hand taps, dies and hand reamers..........447
MS-19 Identifying power tool safety practices..........449
MS-20 Assembling and fitting..........451
MS-21 Identifying fasteners..........453
MS-22 Using thread, center, fillet and radius gages..........455
MS-23 Identifying lubricants and greases..........457
MS-24 Performing machine maintenance..........459
MS-25 Identifying bench work safety..........461
MS-26 Identifying parts and functions of the drilling machine..........463
MS-27 Identifying safety practices and precautions when using the drilling machine..........465
MS-28 Identifying work-holding devices and set ups..........467
MS-29 Identifying and using drill bit holding devices..........469
MS-30 Identifying drill bits..........471
MS-31 Identifying cutting feeds and speeds..........473
MS-32 Identifying principles of straight drilling..........475
MS-33 Identifying and using coolants and cutting compounds..........477
MS-34 Grinding and caring of drills..........479
MS-35 Identifying and using twist drill gages..........481
MS-36 Identifying and using drill grinding machines..........483
MS-37 Identifying machine reamers..........485
MS-38 Performing machine reaming with the drilling machine..........487
MS-39 Identifying principles of boring and counterboring..........489
MS-40 Using the drill press in spot facing operations..........491

| | | Page No. |
|---|---|---|
| MS-41 | Performing counter sinking and center drilling operations | 493 |
| MS-42 | Identifying lathe safety | 495 |
| MS-43 | Identifying lathes | 497 |
| MS-44 | Identifying work-holding devices | 499 |
| MS-45 | Identifying cutting tools | 501 |
| MS-46 | Identifying measuring tools | 503 |
| MS-47 | Identifying lathe attachments | 505 |
| MS-48 | Calculating cutting feeds and speeds on the lathe | 507 |
| MS-49 | Determining RPM | 509 |
| MS-50 | Centering stock | 511 |
| MS-51 | Identifying principles of facing | 513 |
| MS-52 | Identifying principles of straight turning and turning to shoulders | 515 |
| MS-53 | Identifying chucks | 517 |
| MS-54 | Performing form turning operations | 519 |
| MS-55 | Identifying principles of faceplate work | 521 |
| MS-56 | Using draw-in collets | 523 |
| MS-57 | Identifying principles of drilling | 525 |
| MS-58 | Identifying machine reamers | 527 |
| MS-59 | Performing reaming operations on the engine lathe | 529 |
| MS-60 | Performing boring operations on the engine lathe | 531 |
| MS-61 | Identifying and using mandrels | 533 |
| MS-62 | Performing knurling operations on the engine lathe | 535 |
| MS-63 | Performing cutting off operations on the engine lathe | 537 |
| MS-64 | Identifying thread cutting devices | 539 |
| MS-65 | Identifying the parts of a thread | 541 |
| MS-66 | Identifying American National thread standards | 543 |
| MS-67 | Computing American National thread form | 545 |
| MS-68 | Computing sharp V-thread formulas | 547 |
| MS-69 | Identifying acme threads | 549 |
| MS-70 | Using the acme tap | 551 |
| MS-71 | Identifying square threads | 553 |
| MS-72 | Identifying classes of fits of screw threads | 555 |
| MS-73 | Using thread gages | 557 |
| MS-74 | Using a thread micrometer | 559 |
| MS-75 | Measuring threads using the three-wire method | 561 |
| MS-76 | Cutting threads with an even geared lathe | 563 |
| MS-77 | Cutting threads on a lathe which is not even geared | 565 |
| MS-78 | Cutting threads on a quick-change gear lathe | 567 |
| MS-79 | Identifying multiple lead screw threads | 569 |
| MS-80 | Cutting left hand threads | 571 |
| MS-81 | Determining a tap drill size | 573 |

Page No.

MS-82 Cutting internal threads and performing tapping operation.....575
MS-83 Identifying principles of taper turning.....577
MS-84 Computing tapers.....579
MS-85 Measuring short tapers.....581
MS-86 Gaging inside and outside tapers.....583
MS-87 Tapering using the offset tailstock method.....585
MS-88 Cutting a taper using the compound rest.....587
MS-89 Cutting a taper using the taper attachment.....589
MS-90 Boring or turning internal tapers.....591
MS-91 Identifying coolants and cutting compounds.....593
MS-92 Identifying lubricants.....595

## DUTY IV: Welding

WLD-01 Identifying and using welding symbols.....597
WLD-02 Using welding related shop tools.....599
WLD-03 Identifying and preparing metals for welding.....601
WLD-04 Measuring welding materials.....605
WLD-05 Using clamps and jigs.....607
WLD-06 Reading blueprints.....609

## DUTY V: Oxyacetylene Welding, Cutting, Brazing and Soldering

OXA-01 Following safety procedures and regulations for oxyacetylene welding.....611
OXA-02 Using oxyacetylene cylinders and gases.....613
OXA-03 Inspecting oxygen and acetylene regulators.....615
OXA-04 Selecting and maintaining oxyacetylene torches and tips.....617
OXA-05 Setting up and lighting the oxyacetylene torch.....619
OXA-06 Carrying a puddle without a filler rod.....621
OXA-07 Welding an outside corner joint without a filler rod.....623
OXA-08 Making beads with filler rods.....625
OXA-09 Welding butt joints.....627
OXA-10 Welding lap joints.....629
OXA-11 Welding T-joints.....631
OXA-12 Setting up the oxyacetylene apparatus for flame cutting.....633
OXA-13 Cutting with an oxyacetylene cutting torch.....635
OXA-14 Piercing and cutting holes.....637
OXA-15 Cutting with an automatic oxyacetylene cutting machine.....639
OXA-16 Welding beads with brass rods.....641

Page No.

OXA-17 Brazing a lap joint using oxyacetylene apparatus....643
OXA-18 Brazing with silver....645
OXA-19 Soldering copper, sheet metal and other metals....647
OXA-20 Welding cast iron....649
OXA-21 Cutting and welding pipe....651

## DUTY VI: Shielded Arc Welding

ARC-1 Selecting and setting up shielded arc welding apparatus....653
ARC-2 Welding string and weave beads....655
ARC-3 Arc welding string beads and padding a plate....657
ARC-4 Arc welding lap joints....659
ARC-5 Arc welding butt joints....661
ARC-6 Shield arc welding T-fillet joints....663
ARC-7 Testing arc welded joints....665

## DUTY VII: Air Conditioning and Heating

AC-01 Identifying major components and functions of air conditioning systems....667
AC-02 Applying basic air principles....669
AC-03 Calculating heat loads....671
AC-04 Applying principles of air movement....673
AC-05 Servicing air filtering systems....675
AC-06 Installing condensate drains....677
AC-07 Installing residential and mobile home package air conditioning units....679
AC-08 Installing split system air conditioning units....681
AC-09 Installing add-on split air conditioning systems....683
AC-10 Troubleshooting compressor burnout....685
AC-11 Troubleshooting fans and fan motors....687
AC-12 Performing pre-season start-up and air conditioner service....689
AC-13 Troubleshooting air conditioner refrigeration cycle....691
AC-14 Troubleshooting air conditioner electrical cycle....693
AC-15 Troubleshooting air conditioner air movement....695

Page No.

AC-16 Applying principles of the heat pump..............697
AC-17 Evacuating and charging a heat pump..............699
AC-18 Installing a reversing valve..............701
AC-19 Tracing the heat pump refrigeration cycle..............703
AC-20 Installing electrical circuits..............705
AC-21 Adjusting and repairing defrost controls..............707
AC-22 Installing package heat pumps..............709
AC-23 Installing split-system heat pumps..............711

## DUTY VIII: Heating

HE-01 Applying principles of electric furnaces and controls..............713
HE-02 Installing electric furnaces..............715
HE-03 Troubleshooting electric furnaces..............717
HE-04 Applying gas fuel combustion and safety principles..............719
HE-05 Identifying major components and functions of gas heating systems..............721
HE-06 Checking gas sources..............723
HE-07 Applying gas piping principles..............725
HE-08 Installing and adjusting gas regulators..............727
HE-09 Installing and servicing gas valves..............729
HE-10 Installing and servicing pilot ignition devices..............731
HE-11 Installing and servicing combination gas valves..............733
HE-12 Servicing gas burners..............735
HE-13 Inspecting and adjusting temperature rise of heat exchangers..............737
HE-14 Venting gas heating systems..............739
HE-15 Servicing gas furnace electrical controls..............741
HE-16 Determining combustion efficiency..............743
HE-17 Performing a pre-season check-up and start-up on a gas furnace..............745
HE-18 Troubleshooting the gas heating system..............747
HE-19 Identifying types of fuel oil and their principles of combustion..............749
HE-20 Designing and installing oil piping..............751
HE-21 Installing oil burners..............753
HE-22 Installing and servicing transformers and electrodes..............755
HE-23 Installing oil pumps..............757
HE-24 Servicing blower, nozzle, motor and coupling..............759
HE-25 Performing the combustion efficiency test..............761
HE-26 Installing controls..............763
HE-27 Performing pre-season start-up and check-up on an oil burning heating system..............765
HE-28 Troubleshooting the oil burning heating system..............767

Page No.

## DUTY IX: Sheet Metal

SM-01 Identifying materials used in sheet metalwork....769
SM-02 Developing sheet metal patterns....771
SM-03 Cutting sheet metal....773
SM-04 Bending sheet metal by hand....775
SM-05 Bending metal on a bar folder or brake....777
SM-06 Roll-forming sheet metal....779
SM-07 Making seams....781
SM-08 Using the rotary machine....783
SM-09 Fastening sheet metal....785

## DUTY X: Vehicle Maintenance

VM-01 Reading and interpreting the shop service manual....787
VM-02 Identifying and maintaining shop tools and equipment....789
VM-03 Using precision measurement tools and equipment....791
VM-04 Demonstrating an understanding of engine theories of operation....793
VM-05 Demonstrating a knowledge of electricity fundamentals....795
VM-06 Demonstrating an understanding of fuels....797
VM-07 Demonstrating an understanding of lubricants....799
VM-08 Demonstrating an understanding of hardware and fasteners....801
VM-09 Demonstrating basic metals operations....803
VM-10 Demonstrating welding and soldering techniques....805

## DUTY XI: Automotive Systems Repair

VM-11 Checking and changing engine oil and oil filter....807
VM-12 Checking fluid level and refilling transmission and rear end....809
VM-13 Lubricating chassis and components....811
VM-14 Checking and replacing windshield wiper blades....813
VM-15 Repairing tires and tubes....815
VM-16 Replacing light bulbs and fuses....817
VM-17 Washing and waxing vehicle....819
VM-18 Adjusting fuel/air mixtures and mechanical linkage....821
VM-19 Cleaning or replacing fuel air and air filters....823
VM-20 Removing carburetor from engine....825
VM-21 Disassembling, cleaning and inspecting carburetor....827
VM-22 Reassembling and testing carburetor....829

Page No.

VM-23 Testing and replacing fuel pumps................831
VM-24 Servicing fuel tank, lines, hoses and fuel level monitoring devices.................833
VM-25 Diagnosing fuel system problems.................835
VM-26 Inspecting, selecting and installing spark plugs...................................837
VM-27 Timing the ignition.............................839
VM-28 Inspecting and replacing circuit wiring, distributor cap and rotor......................841
VM-29 Testing, removing and replacing battery ignition components...........................843
VM-30 Testing, removing and replacing electronic ignition components...........................845
VM-31 Using and interpreting the ignition analyzer.......................................847
VM-32 Diagnosing ignition system problems..............849
VM-33 Servicing battery and cables....................851

## DUTY XII: Carpentry

C-01 Reading a rule..................................853
C-02 Reading a scale.................................855
C-03 Reading orthographic drawings...................857
C-04 Identifying elevations..........................859
C-05 Identifying symbols.............................861
C-06 Using hand tools (tooth cutting, edge cutting, boring, assembly and smoothing tools).....................................863
C-07 Using measuring tools...........................865
C-08 Using fasteners (nails, screws, glue)...........867
C-09 Using portable power tools (saws, drills, router and sanders)...........................869
C-10 Surfacing stock, jointing edges and dressing lumber to thickness.......................871
C-11 Ripping stock...................................873
C-12 Cutting stock to length.........................875
C-13 Using the band saw and scroll saw...............877
C-14 Using the shaper and overarm router.............879
C-15 Making wood joints..............................881
C-16 Using the wood lathe to turn stock..............883
C-17 Boring holes and cutting plugs..................885
C-18 Sanding flat surfaces...........................887

## TASK

IPM-01 Identifying basic principles of blueprint reading

## PERFORMANCE OBJECTIVE

Identify basic principles of blueprint reading.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Blueprints
   1. Purpose
   2. Why blueprints are used
b. Title block
   1. Name
   2. Scale
   3. Assembly drawing number
   4. Unit or assembly
   5. Drawing number
   6. Part number
   7. Required parts
   8. Drafting room record
   9. Material
   10. Limits
c. Lines
d. Notes

(Continued on back)

Provide Practical Application On:

Reading basic information on a blueprint and interpreting its meaning

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Willis, Blueprint Reading for Commercial Construction
b. Jensen and Hines, Interpreting Engineering Drawings

A/Vs:

Career Aids, Inc., "Drafting and Blueprint Reading Series," transparency/tape

Student Manuals:

Plant Engineering Training Systems, Basic Blueprint Reading, Lesson One

Tools and Equipment:

Blueprints

| | |
|---|---|
| **LAB HOURS** | 2 |
| **CLASS HOURS** | 3 |

**EVALUATION** (IPM-01)

Given a blueprint, the student will read and interpret the basic data on the blueprint. The reading must meet standards as set by the instructor.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

e. Reason for more than one view of an object
    1. Auxiliary views
    2. Sections
    3. Pictorial drawings

## TASK

IPM-02 Identifying elements of machine drawings

## PERFORMANCE OBJECTIVE

Identify elements of machine drawings.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Machine blueprints
b. Introduction to fasteners
c. Screw threads
    1. Helix
    2. External
    3. Internal
    4. Root
    5. Crest
d. How screw threads are shown on drawings
e. Screw thread specifications
    1. Reading thread specifications
    2. ANSI
    3. Bolts
    4. Studs
    5. Cap screw
    6. Machine screw

(Continued on back)

Provide Practical Information On:

Identifying and describing machine drawings

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Willis, Blueprint Reading for Commercial Construction
b. Jensen and Hines, Interpreting Engineering Drawings

A/Vs:

Career Aids, Inc., "Drafting and Blueprint Reading Series," transparency/tape

Student Manuals:

Plant Engineering Training Systems, Basic Blueprint Reading, Lesson Two

Tools and Equipment:

Machine drawings

**LAB HOURS** 2
**CLASS HOURS** 3

**EVALUATION** (IPM-02)

Given a series of machine drawings, the student will identify and interpret the drawings in terms of appropriate terminology according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

f. Other forms of fastening
    1. Rivets
    2. Welding
g. Transmitting forces within machines
    1. Pin fasteners
    2. Keys
    3. Extension spring
    4. Compression spring
    5. Torsion spring
h. Gear drawings
    1. Gears
    2. Mesh
    3. Spur gears
    4. Bevel gears
    5. Worn gears
    6. Rack and pinion
    7. Involute tooth shape
i. Bearing drawing
    1. Journal or sleeve bearing
    2. Plain bearing
j. Identifying bearing drawings
    1. Ball, roller and needle bearings
    2. Low friction bearings
    3. Races
    4. Thrust load
k. Pulley and belt drawings

## TASK

IPM-03 Identifying hydraulic and pneumatic drawings

## PERFORMANCE OBJECTIVE

Identify, read and interpret hydraulic and pneumatic drawings.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Fluid systems
b. Pascal's Law
c. Multiplication of forces
d. Pistons and cylinders
e. Basic fluid components
    a. Reservoir
    2. Pump
    3. Piping
    4. Control valve
    5. Actuating unit
    6. Hydraulic and pneumatic system drawing symbols

Provide Practical Application On:

Reading hydraulic and pneumatic drawings

## INSTRUCTIONAL MATERIALS

Textbooks:

Pease, Basic Fluid Power

Student Manuals:

Plant Engineering Training Systems, Basic Blueprint Reading, Lesson Three

Tools and Equipment:

Hydraulic and pneumatic system schematics

**LAB HOURS** 2
**CLASS HOURS** 3

## EVALUATION (IPM-03)

Given a series of hydraulic and pneumatic drawings, the student will identify, read and interpret the drawings according to the instructor's specifications.

## TASK

IPM-04 Using machine drawings in the maintenance of machinery and equipment

## PERFORMANCE OBJECTIVE

Use machine drawings in the maintenance of machinery and equipment.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Production machines and drawings
    1. Cutting machines
    2. Bending and forming machines
    3. Molding and casting machines
    4. Rotary action
    5. Reciprocating action

b. Power sources for machines
    1. Hydraulic
    2. Pneumatic
    3. Lathe
    4. Grinder
    5. Milling machine
    6. Arbor

(Contined on back)

Provide Practical Application On:

Interpreting machine drawings to plan machine maintenance

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Willis, Blueprint Reading for Commercial Construction
b. Jensen and Hines, Interpreting Engineering Drawings

A/Vs:

Career Aids, Inc., "Drafting and Blueprint Reading Series," transparency/tape

Student Manuals:

Plant Engineering Training Systems, Basic Blueprint Reading, Lesson Four

Tools and Equipment:

Machine drawings

| | |
|---|---|
| LAB HOURS | 15 |
| CLASS HOURS | 5 |

## EVALUATION (IPM-04)

Given a machine with a maintenance requirement and a machine drawing, the student will read and interpret the machine drawing and recommend necessary maintenance for the machine according to the instructor's specifications.

INSTRUCTIONAL MATERIALS

Provide Information On:

c. Machine assembly and detail drawings
    1. Lubrication and maintenance drawings
    2. Parts list
d. Assembling drawing applications
e. Use of models
f. Equipment pictorials
g. Exploded pictorial drawings
h. Manufacturing illustrations and maintenance illustrations
i. Using drawings in maintenance of machinery and equipment
    1. Prevention
    2. Service manuals

## TASK

IPM-05 Reading building drawings

## PERFORMANCE OBJECTIVE

Read and interpret building drawings.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. How blueprints can make a job easier
b. Building and building sites
c. Symbols and conventions on drawings
d. Plot plan
    1. Boundaries, bearings, distances
    2. Degrees and minutes
e. Site plan
f. Building drawings
g. Working drawings
    1. Structural drawings
    2. Elevation drawings
    3. Flow diagram

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Willis, Blueprint Reading for Commercial Construction
b. Jensen and Hines, Interpreting Engineering Drawings

A/Vs:

Career Aids, Inc., "Drafting and Blueprint Reading Series," transparency/tape

Student Manuals:

Plant Engineering Training Systems, Basic Blueprint Reading, Lesson Five

Tools and Equipment:

Building drawings

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 3 |

## EVALUATION (IPM-05)

Given a building drawing, the student will read and interpret the drawing according to the instructor's specifications.

## TASK

IPM-06 Reading electrical drawings

## PERFORMANCE OBJECTIVE

Read and interpret electrical drawings.

## INSTRUCTIONAL ACTIVITIES

**Provide Information On:**

a. Wiring diagram applications
b. Using power distribution diagrams
    1. Loads
    2. Circuit breakers or fuses
c. Power distribution circuits
    1. Primary transformer winding
    2. Secondary transformer winding
    3. Neutral or identified conductor
    4. Hot conductor
d. Electrical drawings
    1. Plot plans
    2. Riser drawings

(Continued on back)

**Provide Practical Application On:**

Reading and interpreting electrical blueprints

## INSTRUCTIONAL MATERIALS

**Textbooks:**

a. Willis, *Blueprint Reading for Commercial Construction*
b. Jensen and Hines, *Interpreting Engineering Drawings*

**A/Vs:**

Career Aids, Inc., "Drafting and Blueprint Reading Series," transparency/tape

**Student Manuals:**

Plant Engineering Training Systems, *Basic Blueprint Reading, Lesson Six*

**Tools and Equipment:**

Electrical blueprints

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 3 |

## EVALUATION (IPM-06)

Given an electrical blueprint, the student will read and interpret the drawing according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    3. Single line wiring diagram
    4. Title blocks
e. Electrical blueprint application
f. Plant wiring requirements
    1. Conduit
    2. Flexible arm and wiring or BX cable
    3. Explosion proof wiring
g. Safety

## TASK

IPM-07 Reading pipe system drawings

## PERFORMANCE OBJECTIVE

Read and interpret pipe system drawings.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Application of piping diagrams
    1. Single-line piping diagram
    2. Riser diagrams
b. Purpose of piping systems
    1. Distribution
    2. Waste
c. Piping materials
    1. Copper
    2. Iron and steel
d. Pipe fittings
    1. Street elbow
    2. Coupling
    3. Plug
e. Use of valves
    1. Dreck valves
    2. Direction of flow

(Continued on back)

Provide Practical Application On:

Reading and interpreting pipe system drawings

## INSTRUCTIONAL MATERIALS

Textbooks:

Pease, Basic Fluid Power

Student Manuals:

Plant Engineering Training Systems, Basic Blueprint Reading, Lesson Seven

Tools and Equipment:

Pipe system diagrams

**LAB HOURS** 2

**CLASS HOURS** 2

**EVALUATION** (IPM-07)

Given a pipe system drawing, the student will read and interpret the drawing according to the instructor's specifications.

INSTRUCTIONAL MATERIALS

Provide Information On:

f. Pipe system drawings
    1. Scale layouts and single-line layouts
    2. Orthographic projections
    3. Elevation and plan
    4. Developed diagrammatic layouts
g. Pictorial piping diagrams
h. Architectural piping diagrams

## TASK

IPM-08 Reading sheet metal drawings

## PERFORMANCE OBJECTIVE

Read and interpret sheet metal drawings.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Uses of sheet metal
   1. Galvanized
   2. Aluminum
b. Duct system drawings
c. Ventilation system components and symbols
   1. Ducts
   2. Duct sections
   3. Direction of flow
   4. Supply outlets
   5. Return or exhaust grills
   6. Access doors
   7. Dampers
   8. Dual duct system
   9. Through ceiling type diffusers
   10. Sill aerators

(Continued on back)

Provide Practical Application On:

Reading and interpreting sheet metal drawings

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Feirer, General Metals
b. Walker, Modern Metal-Working

A/Vs:

Career Aids, Inc., "Sheet Metal Work Explained," filmstrip

Student Manuals:

Plant Engineering Training Systems, Basic Blueprint Reading, Lesson Eight

Tools and Equipment:

Sheet metal drawings

**LAB HOURS** 2

**CLASS HOURS** 3

## EVALUATION (IPM-08)

Given a sheet metal drawing, the student will read and interpret the drawing according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

d. Forming sheet metal parts
    1. Developments
    2. Parallel developments
    3. Truncated cylinders
    4. Radial developments
    5. Truncated pyramids
    6. Triangulated developments
e. Sheet metal connection drawings

## TASK

IPM-09 Using shop math to interpret blueprints

## PERFORMANCE OBJECTIVE

Use shop math to interpret blueprints.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Calucating dimensions on blueprints
    1. Straight line measurements
    2. Fractions
    3. Decimals
b. Addition
c. Subtraction
d. Multiplication
e. Divisions
f. Adding and subtracting decimals
g. Multiplying decimals
h. Adding and subtracting fractions
    1. Numerator
    2. Denominator
    3. Common denominator

(Continued on back)

Provide Practical Application On:

Caculating dimensions on blueprints

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Delmar, Mathematics for the Shop
b. Hobar, Practical Problems in Math Series

Student Manuals:

Plant Engineering Training Systems, Basic Blueprint Reading, Lesson Nine

Tools and Equipment:

Blueprints

**LAB HOURS** 15

**CLASS HOURS** 5

## EVALUATION (IPM-09)

Given a blueprint with dimensions which are not labeled, the student will calculate the dimensions according to the instructor's specifications. The student will also read and interpret the blueprint.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    4. Mixed numbers
    5. Proper and improper fractions
i. Multiplying fractions
j. Dividing fractions
k. Angles
    1. Degrees, minutes and seconds
    2. Adjacent angles
    3. Opposite angles
l. Areas of rectangles
m. Radius

## TASK

IPM-10 Sketching schematic diagrams

## PERFORMANCE OBJECTIVE

Sketch a schematic diagram.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Visualizing the drawing
b. Applying sketching techniques
    1. Dimensions
    2. Written descriptions
c. Orthographic sketching
d. Pictorial sketching
e. Isometric sketching
f. Oblique sketching
    1. Cabinet sketching
    2. Cavalier sketching
g. Perspective sketching
h. Shading
    1. Continuous tone
    2. Line tone
i. Sketching a schematic diagram

Provide Practical Application On:

Drawing/sketching a schematic diagram from specifications

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Willis, Blueprint Reading for Commercial Construction
b. Jensen and Hines, Interpreting Engineering Drawings

A/Vs:

Career Aids, Inc., "Drafting and Blueprint Reading Series," transparency/tape

Student Manuals:

Plant Engineering Training Systems, Basic Blueprint Reading, Lesson Ten

Tools and Equipment:

a. Pencils
b. Drawing media

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (IPM-10)

Given specifications and necessary supplies, the student will sketch a schematic diagram according to the instructor's specifications.

## TASK

IPM-11 Identifying types of schematics used in plant engineering

## PERFORMANCE OBJECTIVE

Identify types of schematics used in plant engineering.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Purpose of symbols
b. Schematic
c. Why plant maintenance engineers must be able to read schematics
d. Why schematics are used
e. Electrical diagrams
f. Piping diagrams
g. Fluid power diagrams
h. Using schematics in plant maintenance
i. Cutaway diagram
j. Pictorial diagram
k. Combination diagram

Provide Practical Application On:

a. Interpreting a schematic
b. Interpreting a piping diagram

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Morrow, Plant Engineering Handbook
b. Smith, Electricity for Refrigeration, Heating and Air Conditioning

A/Vs:

Career Aids, Inc., "Basic Electricity and Electronics Explained," filmstrip

Student Manuals:

Plant Engineering Training Systems, Reading Schematics and Symbols, Lesson One

Tools and Equipment:

a. Schematic diagrams
b. Piping diagrams

| | |
|---|---|
| LAB HOURS | 10 |
| CLASS HOURS | 5 |

4~

## EVALUATION (IPM-11)

Given a schematic diagram and a piping diagram, the student will correctly identify basic symbols and read the diagram according to the instructor's specifications.

## TASK

IPM-12 Identifying the symbols on electrical, piping and fluid power diagrams

## PERFORMANCE OBJECTIVE

Identify the symbols used on electrical, piping and fluid power diagrams.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. The meaning of lines
   1. Electrical
   2. Piping
   3. Fluid power
b. Legend
c. Kinds of lines
d. Symbols as opposed to pictures
e. Linking the symbols to form a system
f. Determining the type of system from a diagram
g. How the elements connect in a system

Provide Practical Application On:

Determining the type of system from a diagram

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Morrow, Plant Engineering Handbook
b. Bobbs-Merrill, Industrial Electronic Systems
c. Howard W. Sams & Co., Inc., Collected Basic Circuits

A/Vs:

Career Aids, Inc., "Basic Electricity and Electronics Explained," filmstrip

Student Manuals:

Plant Engineering Training Systems, Reading Schematics and Symbols, Lesson Two

Tools and Equipment:

Electrical, piping and fluid power idagrams

| | |
|---|---|
| LAB HOURS | 20 |
| CLASS HOURS | 10 |

## EVALUATION (IPM-12)

Given an electrical, piping or fluid power diagram, the student will correctly identify the type of system diagrammed and identify the purpose of each symbol used. All diagram identifications should be within the instructor's specifications.

## TASK

IPM-13 Identifying guidelines for reading schematics

## PERFORMANCE OBJECTIVE

Identify guidelines for reading schematics.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Look for the flows in the system
   1. Piping flows
   2. Electrical flows, AC, DC
b. Looking for clues
   1. Check valves
   2. Gage symbols
   3. Combination symbols
c. Reading diagrams carefully
d. Troubleshooting guidelines
   1. Getting a grasp on the whole system
   2. Identifying the problem
   3. Determining possible causes for the problem
   4. Studying a local area of the schematic

Provide Practical Application On:

Looking at diagrams and determining direction of flow

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Smith, Electricity for Refrigeration, Heating and and Air Conditioning
b. Morrow, Maintenance Engineering Handbook

Student Manuals:

Plant Engineering Training Systems, Reading Schematics and Symbols, Lesson Three

Tools and Equipment:

Electrical, piping and fluid power diagrams

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 3 |

## EVALUATION (IPM-13)

Given an electrical, piping or fluid power diagram, the student will interpret the diagram and correctly identify the direction of the flow according to the instructor's specifications.

## TASK

IPM-14 Identifying electrical symbols

## PERFORMANCE OBJECTIVE

Identify electrical symbols.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Importance of following troubleshooting procedures
b. Wires
    1. Connections
    2. Crossings
c. Switches
    1. Disconnect
    2. Push button
d. Power sources
    1. Positive terminal
    2. Negative terminal
e. Electrical loads
f. Coils, inductors and transformers
g. Fuses, circuit breakers and grounds
h. Contacts and resistors
    1. Contact N.O.;N.C.

(Continued on back)

Provide Practical Application On:

Identifying electrical symbols on a schematic

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Loper and Ahr, Electricity and Electronics
b. Delmar, Electronics, Electricity, Electro-Mechanical Technology
c. Howard W. Sams & Co., Inc., How to Read a Schematic Diagram

Student Manuals:

Plant Engineering Training Systems, Reading Schematics and Symbols, Lesson Four

Tools and Equipment:

Electrical schematics

LAB HOURS 2
CLASS HOURS 3

**EVALUATION** (IPM-14)

Given a schematic diagram, the student will identify electrical symbols and describe their purpose in the schematic. The completed task should be in accordance with the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

2. Fixed resistors
3. Adjustable resistors, rheostats, potentiometers

i. Connecting symbols

## TASK

IPM-15 Reading electrical diagrams

## PERFORMANCE OBJECTIVE

Read an electrical diagram.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Electrical schematic diagrams
b. Wiring diagrams
c. Wires shown as lines or color coded
d. Wiring diagram and schematic compared
e. Components
    1. Power source
    2. Load
    3. Wires
f. Switches
g. Series and parallel circuits
h. A systems approach to reading electrical diagrams
i. Making an industrial schematic

Provide Practical Application On:

Reading an electrical diagram to trace a component of a system

## INSTRUCTIONAL MATERIALS

Textbooks:

Howard W. Sams & Co., Inc., How to Read Schematic Diagrams

Student Manuals:

Plant Engineering Training Systems, Reading Schematics and Symbols, Lesson Five

Tools and Equipment:

Electrical diagram and system

**LAB HOURS** 5
**CLASS HOURS** 5

## EVALUATION (IPM-15)

Given an electrical diagram, the student will trace the wiring of the circuit to a specified component. The completed task must meet the instructor's requirements.

## TASK

IPM-16 Identifying piping symbols

## PERFORMANCE OBJECTIVE

Identify piping symbols.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Pipes transfer fluids and gases
b. Piping diagrams
   1. Controlled flow valves
   2. Importance of piping systems
   3. Methods of drawing piping diagrams
c. Differing views
   1. Orthographic projection
   2. Isometric
d. Types of joints
   1. Screwed
   2. Welded
   3. Flanged
   4. Bell-and-spigot
   5. Soldered
e. Fittings

(Continued on back)

Provide Practical Application On:

Identifying symbols on a piping diagram

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Morrow, Maintenance Engineering Handbook
b. Willis, Blueprint Reading for Commercial Construction

A/Vs:

Career Aids, Inc., "Drafting and Blueprint Reading," transparency/tape

Student Manuals:

Plant Engineering Training Systems, Reading Schematics and Symbols, Lesson Six

Tools and Equipment:

Piping diagrams

**LAB HOURS** 2

**CLASS HOURS** 3

## EVALUATION (IPM-16)

**Given a piping diagram, the student will correctly identify the symbols according to the instructor's specifications.**

INSTRUCTIONAL ACTIVITIES

Provide Information On:

1. Changing direction of flow
2. Changing the size of the pipe
3. Providing branch connections

f. Closing pipe line

## TASK

IPM-17 Reading piping schematics

## PERFORMANCE OBJECTIVE

Read a piping schematic.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Piping systems
   1. Joints
   2. Fittings
   3. Valves
   4. Gate valve
   5. Plug valve
   6. Globe valve
   7. Check valve

b. Reading a single schematic

Provide Practical Application On:

Reading a simple piping schematic

## INSTRUCTIONAL MATERIALS

Textbooks:

Willis, Blueprint Reading for Commercial Construction

Student Manuals:

a. Plant Engineering Training Systems, Reading Schematics and Symbols, Lesson Seven
b. Oregon, Symbols
c. Oregon, Basic Symbols

Tools and Equipment:

Piping schematics

**LAB HOURS** 5

**CLASS HOURS** 5

## EVALUATION (IPM-17)

Given a simple schematic of a piping system, the student will read and interpret the schematic according to the instructor's specifications.

## TASK

IPM-18 Identifying fluid power symbols

## PERFORMANCE OBJECTIVE

Identify fluid power symbols.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Elements of a system
   1. Pump
   2. Fluid
   3. Piping
b. Pneumatics
c. Hydraulics
d. Reservoir or receiver
e. Pump or compressor
   1. Fixed displacement pump
   2. Variable displacement pump
f. Actuator
   1. Linear actuator
   2. Single or double acting cylinders
   3. Differential cylinders
   4. Rotary actuator

(Contined on back)

Provide Practical Application On:

Identifying symbols on a fluid power schematic

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

A/Vs:

Howard W. Sams & Co., Inc., "Fluid Power," transparency

Student Manuals:

Plant Engineering Training Systems, Reading Schematics and Symbols, Lesson Eight

Tools and Equipment:

Fluid power schematics

**LAB HOURS** 2

**CLASS HOURS** 3

**EVALUATION** (IPM-18)

Given a fluid power schematic, the student will correctly identify symbols on the schematic.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    5. Fixed or variable displacement
g. Valves
    1. Power or directional
    2. Mechanical or electrical
h. Describing valves by
    1. The number of ways fluids enter or leave the valve
    2. The number of positions the valve can operate
i. Tubing or piping

## TASK

IPM-19 Reading fluid power schematics

## PERFORMANCE OBJECTIVE

Read fluid power schematics.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Composite symbols
- b. Tracing fluid power circuits
- c. Hydraulic circuits
- d. Pneumatic circuits
- e. Types of fluid power diagrams
  - 1. Pictorial
  - 2. Cutaway
  - 3. Schematic

Provide Practical Application On:

Reading a simple fluid power schematic

## INSTRUCTIONAL MATERIALS

Textbooks:

- a. Pease, Basic Fluid Power
- b. Stewart and Storer, Fluid Power

Student Manuals:

Plant Engineering Training Systems, Reading Schematics and Symbols, Lesson Nine

Tools and Equipment:

Fluid power schematics

**LAB HOURS** 2

**CLASS HOURS** 3

**EVALUATION** (IPM-19)

Given a fluid power schematic, the student will correctly read and interpret symbols and direction of flow on the schematic.

## TASK

IPM-20 Identifying welding symbols

## PERFORMANCE OBJECTIVE

Identify welding symbols.

## INSTRUCTIONAL ACTIVITIES

**Provide Information On:**

a. Welding processes
   1. Pressure welding
   2. Non-pressure welding
b. Three methods of fusion welding
   1. Arc welding
   2. Gas welding
   3. Resistance welding
c. Assembled welding symbol
   1. Reference line
   2. Arrow
   3. Basic weld symbol
   4. Dimensions and other data
   5. Supplementary symbols
   6. Finish symbol
   7. The tail

(Continued on back)

**Provide Practical Application On:**

Identifying and interpreting welding symbols

## INSTRUCTIONAL MATERIALS

**Textbooks:**

Griffin and Roden, Welding Processes

**A/Vs:**

Hobar, "Blueprint Reading for Welders," transparency

**Student Manuals:**

Plant Engineering Training Systems, Reading Schematics and Symbols, Lesson Ten

**Tools and Equipment:**

Welding diagram

**LAB HOURS** 2

**CLASS HOURS** 4

## EVALUATION (IPM-20)

Given a welding symbol, the student will identify and interpret the symbol according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    8. Specifications, processes and other references
d. Location of the weld
e. Symbols
    1. Weld-all-around
    2. Spot, seam, flash
    3. Break in arrow of bevel and J-groove
    4. Combination symbols
f. Special weld designations
    1. Cross section view on detail drawing
    2. Field weld symbol

## TASK

IPM-21 Identifying and using basic measuring tools

## PERFORMANCE OBJECTIVE

Identify basic measuring tools.

## INSTRUCTIONAL ACTIVITIES

**Provide Information On:**

a. Classifying measuring tools
  1. Linear measurement
  2. Angular measurement
  3. Transferring measurements
b. Rules and tapes
  1. Steel rule
  2. Folding rulers and tapes
  3. Taking measurements
c. Calipers
  1. Inside diameter
  2. Outside diameter
  3. Slide diameter
d. Micrometers
e. Squares

**Provide Demonstration On:**

Procedure for using a micrometer

**Provide Practical Application On:**

Using the following tools to make measurements
1. Calipers
2. Micrometers

## INSTRUCTIONAL MATERIALS

**Texbooks:**

a. Dover Publications, *Tools and Their Uses*
b. Hinrichs, *Measuring*

**A/Vs:**

a. Hobar, "Micrometers,, Calipers and Gages" and "Reading the Micrometers," transparencies
b. DCA Educational Products, "Precision Products," transparency

**Student Manuals:**

Plant Engineering Training Systems, *Hand Tools, Lesson One*

**Tools and Equipment:**

a. Several types of calipers
b. Several types of micrometers
c. Items to measure

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 4 |

## EVALUATION (IPM-21)

Given a measuring tool and an assigned measurement, the student will accurately use the tool and make the measurement. The measurement must be in compliance with the industry's standards.

## TASK

IPM-22 Identifying and using wrenches and screwdrivers

## PERFORMANCE OBJECTIVE

Identify and use wrenches and screwdrivers.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Wrenches
    1. Materials
    2. Uses
    3. Tolerance
b. Types of wrenches
    1. Open-end
    2. Box-end
    3. Combination
    4. Socket, socket handles
    5. Torque wrenches
    6. Socket head, Allen wrenches
c. Using wrenches
d. Screwdrivers
    1. Types of screwdrivers
    2. Dressing the blade
    3. Driving and drawing a screw

(Continued on back)

Provide Demonstration On:

a. Proper use of a torque wrench
b. Dressing the blade of a screwdriver

Provide Practical Application On:

a. Using several types of wrenches
b. Using several types of screwdrivers

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Dover Publications, Tools and Their Uses
b. Hobar, Screwdrivers

A/Vs:

a. Hobar, "Screwdrivers," transparency
b. DCA, "Screwdrivers," transparency

Student Manuals:

Plant Engineering Training Systems, Hand Tools, Lesson Two

Tools and Equipment:

a. Assortment of wrenches
b. Assortment of screwdrivers

| | |
|---|---|
| LAB HOURS | 3 |
| CLASS HOURS | 3 |

## **EVALUATION** (IPM-22)

Given a job which requires the use of wrenches, torque wrenches and screwdrivers, the student will select the appropriate tools and use them according to correct and safe procedures.

INSTUCTIONAL ACTIVITIES

Provide Information On:

4. Care, use and screwdriver safety

## TASK

IPM-23 Identifying and using pipefitting tools

## PERFORMANCE OBJECTIVE

Identify and use pipefitting tools.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Uses of pipe
b. Pipe wrenches
    1. Straight
    2. Stillson
c. How to use pipe wrenches
d. Compound cleverage wrench
e. Strap wrench
f. Chain pipe wrench
g. Cutting pipe
h. Pipe vises
i. Threading and tapping pipes
j. Reaming
k. Tubing and plastic pipe cutters
l. Flaring tools

(Continued on back)

Provide Demonstration On:

The proper way to hold and use a pipe wrench

Provide Practical Application On:

Tightening a pipe fitting with a pipe wrench

## INSTRUCTIONAL MATERIALS

Textbooks:

Dover Publications, Tools and and Their Uses

A/Vs:

Hobar, "Laboratory Exercise in Pipefitting," slide/tape

Student Manuals:

Plant Engineering Training Systems, Hand Tools, Lesson Three

Tools and Equipment:

a. Several types of pipe wrenches
b. Pipes and fittings

| | |
|---|---|
| LAB HOURS | 3 |
| CLASS HOURS | 3 |

**EVALUATION** (IPM-23)

Given a pipe fitting, the student will select the appropriate pipe wrench from the tool room and tighten the fitting using the proper technique. The completed task must comply with the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

m. Pipe tool care
    1. Cleaning and storage
    2. Lubricating
    3. Maintaining

## TASK

IPM-24 Identifying and using plumbing tools

## PERFORMANCE OBJECTIVE

Identify and use plumbing tools.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Three basic areas of plumbing
   1. Water supply
   2. Drainage
   3. Fixtures
b. Plumbing codes
c. The plumbing system
d. The water supply system
e. Tube bending
   1. Tools
   2. Procedure
f. Cutting cast iron sail pipe
g. Using sail pipe assembly tool
h. Force-up plungers
i. Closet augers
j. Line clearing tools

(Continued on back)

Provide Demonstration On:

a. Bending tube
b. Measuring pipe

Provide Practical Application On:

a. Using a tube bender to bend tube
b. Measuring a length of pipe

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Dover Publications, Tools and Their Uses
b. Audel, Plumbers and Pipefitter's Library

Student Manuals:

a. Plant Engineering Training Systems, Hand Tools, Lesson Four
b. MAVCC, Residential Plumbing

**LAB HOURS** 3

**CLASS HOURS** 3

## EVALUATION (IPM-24)

a. Given a selection of plumbing tools, the student will identify and describe each tool and its function with 100% accuracy.

b. Given a length of tube and a tube bender, the student will bend the tube according to specifications designated by the instructor.

c. Given a length of pipe and specifications, the student will correctly measure and cut it according to the instructor's specifications.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

k. Seven tapes
l. Internal wrench
m. Basin wrenches
n. End-hex wrenches
o. Measuring pipe

## TASK

IPM-25 Identifying and using electrical tools

## PERFORMANCE OBJECTIVE

Identify and use electrical tools.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. EMT Bender
    1. NEC standards for bends
    2. Using the bender
b. Correcting knocked over stubs
c. Bending rigid conduit
d. Hydraulic benders
e. Assembling rigid conduit
f. Fish tapes
    1. Basket cable grip
    2. Wire and cable grip
g. Knock-out punches
h. Pliers
i. Wire and cable strippers
j. Special screwdrivers
    1. Tightening wire connection screwdriver
    2. Off-set screwdriver

(Continued on back)

Provide Demonstration On:

Bending conduit

Provide Practical Application On:

a. Bending a conduit
    1. Flexible
    2. Rigid
b. Using a knock-out punch to punch a hole in box for conduit

## INSTRUCTIONAL MATERIALS

Textbooks:

AAVIM, Electrical Wiring

A/Vs:

Hobar, "Housewiring," filmstrip

Student Manuals:

Plant Engineering Training Systems, Hand Tools, Lesson Five

Tools and Equipment:

a. EMT bender
b. Selection of electrical tools

**LAB HOURS** 3

**CLASS HOURS** 3

## EVALUATION (IPM-25)

Given a selection of tools used in electrical work, the student will identify, describe and utilize each tool necessary for bending a conduit. The bend must comply with the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    3. Screw holding screw-driver
k. Voltage tester
l. Fuse pullers

## TASK

IPM-26 Identifying and using cement, plaster and glazing tools

## PERFORMANCE OBJECTIVE

Identify and use cement, plaster and glazing tools.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Mortars and concrete
b. Brick masonry tools
c. Line and pins
d. Brick and block repairing tools
    1. Tuck pointing
    2. Hammer and chisel
e. Cement masonry tools
f. Jointing, edging and finishing
g. Plastering tools
h. Using plaster application hand tools
i. Repairing plaster
j. Repairing wallboard
k. Glazing tools
l. Replacing broken panes

Provide Demonstration On:

Applying plaster

Provide Practical Application On:

Using the correct tools to apply plaster to a wall

## INSTRUCTIONAL MATERIALS

Textbooks:

a. White, Concrete Technology
b. Moore, Concrete Form Construction
c. Smith, Principles and Practices of Heavy Construction
d. NAVTRA, Builder I & C
e. Prentice-Hall, Masonry and Concrete

(Continued on back)

Student Manuals:

Plant Engineering Training Systems, Hand Tools, Lesson Six

Tools and Equipment:

a. Mortar board
b. Flat board
c. Selection of masonry tools

LAB HOURS 3
CLASS HOURS 3

## EVALUATION (IPM-26)

Given a selection of masonry tools, the student will identify the tool and demonstrate the proper use by applying plaster to a given location.

INSTRUCTIONAL MATERIALS

A/Vs:

a. Hobar Publications, "MTR-II," transparency
b. Hobar Publications, "MTR-IV," transparency
c. Hobar Publications, "MTR-V," transparency
d. Hobar Publications, "MTR-III," transparency

## TASK

IPM-27 Identifying and using woodworking tools

## PERFORMANCE OBJECTIVE

Identify and be able to use woodworking tools.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Handsaws
b. How to use a cross-cut saw
c. How to use a rip saw
d. Special purpose saws
e. Planes
f. Using the plane
g. Boring and drilling holes
h. Hand drills
i. Woodworking chisels
j. Levels
k. Plumb bobs
l. Nail hammers and nail sets
m. Marking gazes-beam and head
n. Wood scrapers
o. Tool maintenance and care

Provide Practical Application On:

Identifying tools in the tool room

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Reed, Residential Carpentry
b. NAVTRA, Builder I & C
c. Dover Publication, Tools and Their Uses

A/Vs:

a. Prentice-Hall, "XF-1121," cassette filmstrip
b. Prentice-Hall, "XF-1120," cassette filmstrip
c. Hobar, "Hammers, Nails and Nailing Techniques," slide/tape

(Continued on back)

Student Manuals:

Plant Engineering Training Systems, Hand Tools, Lesson Seven

LAB HOURS 3
CLASS HOURS 3

## EVALUATION (IPM-27)

Given an assortment of woodworking tools, the student will identify the tool and demonstrate its appropriate use. The task must be in accordance with the instructor's requirements. The following tools will be identified.

1. Handsaws
2. Planes
3. Drills
4. Chisels
5. Levels
6. Hammers

## INSTRUCTIONAL MATERIALS

A/Vs:

d. Hobar, "Transparencies," WHT-1 through WHT-22
e. Bergwall, "Woodworking Handtools Explained," filmstrip

## TASK

IPM-28 Identifying and using sheet metal tools

## PERFORMANCE OBJECTIVE

Identify and use sheet metal tools.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types of sheet metal
b. Sheet metal gazes
c. Sheet metal layout
d. Dividers
e. Punches
f. Rivet set
g. Metal cutting chisels
h. Hammer
i. Metal cutting snips
j. Aviation pattern snips
k. Dressing a cut metal sheet
l. Sheet metal notchers
m. Sheet metal punching tools
n. Bench stakes
o. Sheet metal forming tools
p. Hand seamers
q. Soldering
r. Sheet metal safety

Provide Practical Application On:

Identifying metalworking tools in the tool room and describing/demonstrating the use of the tools

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Ludwig and McCarthy, Metal Work Technology and Practice
b. Walker, Modern Metal-Working

A/Vs:

a. Hobar, "Sheet Metal Hand Tools," transparency
b. Bergwall, "Sheet Metal Work," filmstrip

Student Manuals:

a. Plant Engineering Training Systems, Hand Tools, Lesson Eight
b. California State Department of Education, Sheet Metal Tools and Equipment Workbook

| | |
|---|---|
| LAB HOURS | 3 |
| CLASS HOURS | 3 |

## EVALUATION (IPM-28)

Given a selection of metalworking tools, the student will identify the tool and demonstrate its proper use. The following tools will be identified

1. Sheet metal gages
2. Punches
3. Chisels
4. Rivet sets
5. Hammers
6. Tin snips
7. Forming tools
8. Soldering tools

## TASK

IPM-29 Identifying and using metalworking tools

## PERFORMANCE OBJECTIVE

Identify and be able to use metalworking tools.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Machine's vise
b. Hacksaws
c. Files
d. File cuts
    1. Single
    2. Double
e. File designations
f. File shape
    1. Tapered
    2. Blunt
g. Selecting a file
h. Taps
i. Tap sets
j. Tap sizes
k. Tap wrenches
l. Uses of taps
m. Tapping lubricants
n. Dies

(Continued on back)

Provide Demonstration On:

a. Using a hacksaw properly
b. Proper use of a file

Provide Practical Application On:

a. Using a hacksaw to cut metal properly
b. Using a file on metal observing appropriate procedure

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Ludwig and McCarthy, Metal Work and Technology and Practice
b. Walker, Modern Metal-Working

Student Manuals:

Plant Engineering Training Systems, Hand Tools, Lesson Nine

Tools and Equipment:

a. Hacksaw
b. File
c. Metal material
d. Other examples of metal-working tools

LAB HOURS 3
CLASS HOURS 3

## EVALUATION (IPM-29)

**Given a selection of metalworking tools, the student will correctly identify the tools and use the hacksaw and file in the appropriate manner.**

INSTRUCTIONAL ACTIVITIES

Provide Information On:

o. Obtaining desired fit
p. Using dies
q. Plates
r. Reamers

## TASK

IPM-30 Identifying and using hoisting and pulling tools

## PERFORMANCE OBJECTIVE

Identify and use hoisting and pulling tools.

## INSTRUCTIONAL ACTIVITIES

**Provide Information On:**

a. Block and tackle
    1. Mechanical advantage
    2. Safety
b. Angle of lift
c. Slings
d. Using hitches
    1. Straight
    2. Choker
    3. Basket
    4. Bridle
e. Spreader beams
f. Sling inspection
g. Forged link charms
h. Fabric slings
i. Wire rope slings
j. Chain falls
k. Ropes
    1. Manila rope

(Continued on back)

**Provide Practical Application On:**

Using a block and tackle

## INSTRUCTIONAL MATERIALS

**Textbooks:**

Morrow, Maintenance Engineering Handbook

**Student Manuals:**

Plant Engineering Training Systems, Hand Tools, Lesson Ten

**Tools and Equipment:**

Block and tackle

LAB HOURS 3
CLASS HOURS 3

## EVALUATION (IPM-30)

**Given an assortment of hoisting and pulling tools, the student will identify and describe the proper use of each and demonstrate the proper use of a block and tackle.**

### INSTRUCTIONAL ACTIVITIES

Provide Information On:

    2. Stretching
l. Wire rope and cable
m. Knots and knot terminology
    1. Standing part, bight, end
    2. Reef knot
    3. Square knot
    4. Figure eight knot
    5. Fisherman's knot
    6. Bowline knot
    7. Timber hitch
    8. Clovi hitch
    9. Cat's paw
    10. Round turn and two half-hitches
    11. Sheep shank
    12. Whipped ends
n. Machine part pullers
o. Vow puller
p. Push-pullers
q. Slide hammer puller
r. Choosing the right puller

## TASK

IPM-31 Identifying plant safety procedures

## PERFORMANCE OBJECTIVE

Identify general plant safety procedures.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Who is responsible for safety
b. Accidents and injuries
c. The accident chain
d. Built-in hazards
e. Human influences on safety

Provide Practical Application On:

Identifying dangerous conditions in the shop

## INSTRUCTIONAL MATERIALS

Textbooks:

AAVIM, Developing Shop Safety Skills

A/Vs:

a. AAVIM, "Developing Shop Safety," slide/tape
b. Career Aids, Inc., "Safetitudes," filmstrip
c. Career Aids, Inc., "General Shop Safety," filmstrip

Student Manuals:

a. Plant Engineering Training Systems, Plant Safety, Lesson One
b. AAVIM, Developing Shop Safety Skills

| | |
|---|---|
| LAB HOURS | 0 |
| CLASS HOURS | 2 |

**EVALUATION** (IPM-31)

Given a safety hazard in the shop, the student will locate the safety hazard and correct the situation according to the instructor's specifications.

83

## TASK

IPM-32 Observing safety precautions for tools and equipment

## PERFORMANCE OBJECTIVE

Observe all safety precautions when using tools and equipment.

## INSTRUCTIONAL ACTIVITIES

**Provide Information On:**

- a. Hand tools
  - 1. Defective tools
  - 2. Using wrong tool
  - 3. Right tool, wrong method
  - 4. Improper tool maintenance
- b. Built-in hazards
- c. Powered hand tools
- d. Pneumatic tools
- e. Tool bit safety
- f. Gasoline powered tools
- g. Explosive powered tools
- h. Portable ladders
- i. Step ladders
- j. Ladder safety
- k. Fixed ladders
- l. Ladder inspection
- m. Scaffolds and working platforms

**Provide Practical Application On:**

Describing the safety precautions for using tools in the shop/plant

## INSTRUCTIONAL MATERIALS

**A/Vs:**

- a. Hobar, slide sets SMP-II, SMP-III and SMP-IV
- b. Hobar, "Power Tool Safety and Operation," transparency
- c. Career Aids, Inc., "Using Hand Tools Parts 1 and 2," transparencies
- d. Career Aids, Inc., "Using Power Tools," transparency

**Student Manuals:**

- a. Plant Engineering Training Systems, *Plant Safety, Lesson Four*
- b. Hobar, *Power Tool Safety and Operation*

**Tools and Equipment:**

Selection of shop tools

| | |
|---|---|
| LAB HOURS | 0 |
| CLASS HOURS | 2 |

**EVALUATION** (IPM-32)

Given a selection of shop tools, the student will describe procedures for the safe use of the tools.

## TASK

IPM-33 Identifying machinery safeguards

## PERFORMANCE OBJECTIVE

Identify safeguards when operating machinery.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Machine guards
b. Hazardous motions
    1. High speed rotating parts which appear to stand still
    2. Inrunning nip points
c. Locking out power
d. Locking moving parts
e. Point of operation machinery guarding
f. Barrier and enclosure guards
g. Controls and operating safety
h. Mechanical power transmission guards

Provide Practical Application On:

Describing safety procedures for power tools in the shop

## INSTRUCTIONAL MATERIALS

A/Vs:

Hobar, "Power Tool Safety and Operation," transparency

Student Manuals:

a. Plant Engineering Training Systems, Plant Safety, Lesson Five
b. Hobar, Power Tool Safety and Operation

Tools and Equipment:

Selection of power tools

| | |
|---|---|
| LAB HOURS | 0 |
| CLASS HOURS | 2 |

## EVALUATION (IPM-33)

Given a series of power tools in the shop, the student will accurately identify and describe the safety precautions for each machine.

## TASK

IPM-34 Observing safety in handling materials

## PERFORMANCE OBJECTIVE

Observe all safety precautions when handling materials.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Material handling injuries
   1. Causes
   2. Avoiding injuries
b. Manual lifting, carrying, setting
c. Built-in material hazards
d. Team handling
e. Handling special shapes and sizes
f. Hand tools and accessories
g. Hand trucks, dollies, wheelbarrows
h. Powered industrial trucks
i. Conveyors, chutes, troughs
j. Hoists and cranes
k. Receiving and storage
l. Storage safety
m. Chemicals and flammable materials

(Continued on back)

Provide Practical Application On:

Lifting an object (crate or similar), carrying and setting it in place.

## INSTRUCTIONAL MATERIALS

A/Vs:

Career Aids, Inc., "Lift With Your Head," filmstrip

Student Manuals:

Plant Engineering Training Systems, Plant Safety, Lesson Three

Tools and Equipment:

Crates or other objects to lift

| | |
|---|---|
| LAB HOURS | 0 |
| CLASS HOURS | 2 |

**EVALUATION** (IPM-34)

Given an object, the student will lift, carry and set the object in a designated location. The procedure must be in accordance with the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

n. Materials handling and lighting

## TASK

IPM-35 Identifying work area safety precautions

## PERFORMANCE OBJECTIVE

Identifying safety precautions.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Hazards
    1. Mechanical
    2. Electrical
    3. Chemical
    4. Environmental
b. Built-in hazards
c. Moving machinery
d. Plant traffic
e. Safety at heights
f. Safety in extreme heat
g. Enclosed areas
h. Flammability and toxicity problems
i. Chemical safety
j. Utility maintenance safety
k. Radiation

Provide Practical Application On:

Identifying safety hazards in the work area

## INSTRUCTIONAL MATERIALS

A/Vs:

Career Aids, Inc., "Safety at Work," filmstrip

Student Manuals:

Plant Engineering Training Systems, *Plant Safety, Lesson Two*

| | |
|---|---|
| LAB HOURS | 0 |
| CLASS HOURS | 2 |

## EVALUATION (IPM-35)

Given a safety hazard in the work area, the student will identify the hazard and correct the situation according to the instructor's specifications.

## TASK

IPM-36 Identifying fire prevention procedures

## PERFORMANCE OBJECTIVE

Identify procedures for fire prevention.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. How fires start
  1. Fuel, heat, oxygen
  2. Spontaneous combustion
  3. External ignition
  4. Flash point
b. Volatile liquids, materials
  1. Gasoline
  2. Fuel oils
  3. Carbon monoxide
  4. Dusts, powders
c. Ordinary combustibles
d. Fire prevention
e. Four classes of fire
  1. Class A-ordinary combustibles-extinguishers
  2. Class B-flammable extinguishers

(Continued on back)

Provide Practical Application On:

Choosing the correct fire extinguisher for the appropriate type/class fire

## INSTRUCTIONAL MATERIALS

Textbooks:

Colburn, Fire Protection and Suppression

A/Vs:

Career Aids, Inc., "School Shop Safety," filmstrip

Student Manuals:

Plant Engineering Training Systems, Plant Safety, Lesson Nine

Tools and Equipment:

Four types of fire extinguishers

LAB HOURS 0
CLASS HOURS 2

**EVALUATION** (IPM-36)

Given a description of a fire, the student will correctly choose the type of fire extinguisher which will safely extinguish the fire. The student will also accurately identify fire prevention procedures.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

3. Class C-electrical equipment-extinguishers
4. Class D-combustible metals-extinguishers

## TASK

IPM-37 Handling hazardous materials

## PERFORMANCE OBJECTIVE

Observe safety precautions when handling hazardous materials.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Materials hazards and injuries
  1. Inhaling
  2. Ingestion
  3. Absorption
b. Hazardous liquids
c. Using solvents
  1. Flash point
  2. Ventilation
d. Packaged materials
e. Normal exposure cautions
f. Sudden, unexpected exposure
g. Noise hazards
h. Welding hazards
i. Welding safety

Provide Demonstration On:

Handling solvents

## INSTRUCTIONAL MATERIALS

Textbooks:

Anton, Occupational Safety and Health Management

A/Vs:

Career Aids, Inc., "Safety at Work," filmstrip

Student Manuals:

Plant Engineering Training Systems, Plant Safety, Lesson Eight

Tools and Equipment:

a. Solvents
b. Fuel cans
c. Other hazardous materials

| | |
|---|---|
| LAB HOURS | 0 |
| CLASS HOURS | 2 |

**EVALUATION** (IPM-37)

Given a selection of hazardous materials in the shop, the student will identify the materials and describe the necessary related safety precautions according to the instructor's specifications.

## TASK

IPM-38 Observing electrical safety precautions

## PERFORMANCE OBJECTIVE

Observe all precautions for electrical safety.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Basic electricity
    1. Amperes
    2. Volts
    3. Ohms
    4. Ohm's law
    5. Short circuit
b. Electrical injuries
c. Preventing electrical accidents
d. Overcurrent protection
    1. Fuses
    2. Circuit breakers
e. Grounding
    1. Ground faults
    2. GFC
f. Hazardous location
g. Double insulated tools
h. General electrical safety rules

Provide Demonstration On:

Procedure for treating shock

## INSTRUCTIONAL MATERIALS

A/Vs:

Career Aids, Inc., "Electrical Safety in the Shop," filmstrip; "Electricity/Electronics," filmstrip

Student Manuals:

Plant Engineering Training Systems, Plant Safety, Lesson Seven

LAB HOURS 0

CLASS HOURS 2

**EVALUATION** (IPM-38)

Given electrical safety rules for the shop, the student will identify and describe electrical safety procedures and devices according to the instructor's specifications.

## TASK

IPM-39 Identifying personal protection gear

## PERFORMANCE OBJECTIVE

Identify gear for personal protection.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Head protection
b. Eye protection
c. Face shields
d. Face and body shields
e. Ear protection
f. Foot protection
g. Respiratory protection
h. Processing air for respiration
i. Safety harnesses and lifelines
j. Gloves and special work clothes

Provide Demonstration On:

How to use a gas mask

Provide Practical Application On:

Selecting proper safety devices for assigned jobs

## INSTRUCTIONAL MATERIALS

Textbooks:

University of Missouri, Safety in Trade and Industrial Education Handbook

A/Vs:

University of Missouri, "Safety in Trade and Industrial Education," slide/tape

Student Manuals:

Plant Engineering Training Systems, Plant Safety, Lesson Six

Tools and Equipment:

Selection of safety equipment

(Continued on back)

| | |
|---|---|
| **LAB HOURS** | 0 |
| **CLASS HOURS** | 2 |

## EVALUATION (IPM-39)

Given an assigned job in the shop, the student will choose the appropriate personal safety devices for the job according to the instructor's specifications.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

1. Hard hats
2. Steel toes
3. Face shields
4. Goggles
5. Safety glasses
6. Gas mask

## TASK

IPM-40 Identifying basic principles of lubrication

## PERFORMANCE OBJECTIVE

Identify basic principles of lubrication.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Lubrication
b. Basic purposes of lubricants
    1. Reducing friction
    2. Reducing wear
    3. Dampening shock
    4. Cooling moving elements
    5. Preventing corrosion
    6. Sealing out contaminants
c. Classifications of lubricants
    1. Liquid
    2. Semi-solid
    3. Solid
    4. Gas
d. Sliding and rolling friction
e. Types of motion
    1. Rotary
    2. Linear
    3. Combination
f. Wear
g. Dampening shock
h. Cooling action of lubricants
i. Corrosion prevention
j. Lubricants as seals
k. Other actions of lubricants
    1. Flushing action
    2. Power transmission

## INSTRUCTIONAL MATERIALS

Textbooks:

McGraw-Hill, Standard Handbook of Lubrication

A/Vs:

DCA, "Lubricants," slide/tape

Student Manuals:

Plant Engineering Training Systems, Lubrication, Lesson One

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 4 |

100

## EVALUATION

(IPM-40)

Given an overview of lubricants and their applications, the student will accurately identify basic principles of lubricants and identify their applications.

## TASK

IPM-41 Identifying characteristics of lubricants

## PERFORMANCE OBJECTIVE

Identify characteristics of lubricants.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. History of lubrication
b. General action of lubricants
    1. Preventing corrosion
    2. Protective, slippery film
c. Types of lubricants
d. Refining of lubricants
    1. Petroleum
    2. Wells
e. Manufacture of lubricants
    1. Distillation
    2. Solvent refining
    3. Filtering through special clay
f. Chemistry of lubricants
    1. Elements
    2. Molecules

(Continued on back)

Provide Demonstration On:

Using a laboratory type still to demonstrate refining principles

Provide Practical Application On:

Choosing the appropriate oil and/or grease for a given machine

## INSTRUCTIONAL MATERIALS

Textbooks:

McGraw-Hill, Standard Handbook of Lubrication Engineering

Student Manuals:

Plant Engineering Training Systems, Lubrication, Lesson Two

Tools and Equipment:

a. Laboratory type still
b. Oils
c. Greases

| | |
|---|---|
| LAB HOURS | 0 |
| CLASS HOURS | 3 |

**EVALUATION** (IPM-41)

Given a machine which needs lubrication, the student will accurately select the appropriate oil and/or grease. The selection must be approved by the instructor.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    3. Hydrocarbons
g. Properties of lubricants
    1. Viscosity
    2. Viscosity index
    3. Flash point
    4. Fire point
    5. Pour point
    6. Oxidation resistance
    7. Emulsification and demulsification
h. Viscosity
    1. Fluid thickness
    2. SAE
    3. SSV, SVS
    4. Viscometer
i. Greases
    1. Soap
    2. Hardness
    3. Dropping point
j. Lubricant selection
    1. Load
    2. Speed
    3. Pressure
    4. Environment
    5. Pumpability
    6. Water resistance
    7. Stability

## TASK

IPM-42 Identifying additives, lubricating action and bearing lubrication

## PERFORMANCE OBJECTIVE

Identify additives, lubricating action and bearing lubrication.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Additives
    1. Purpose
    2. Types
b. Multi-purpose lubricants
c. Types of lubricants
    1. Dry friction
    2. Mixed film
    3. Boundary lubrication
    4. Full film
d. Bearings
    1. Plain bearings
    2. Anti-friction bearings
e. Plain bearing types
    1. Journal bearings
    2. Thrust bearings
    3. Guide or slipper bearings
f. Journal bearings
    1. Solid bearings

(Continued on back)

Provide Practical Application On:

Greasing bearings on a machine

## INSTRUCTIONAL MATERIALS

Textbooks:

McGraw-Hill, Standard Handbook of Lubrication Engineering

Student Manuals:

Plant Engineering Training Systems, Lubrication, Lesson Three

Tools and Equipment:

a. Oil
b. Grease
c. Funnel
d. Grease gun

**LAB HOURS** 2

**CLASS HOURS** 4

**EVALUATION** (IPM-42)

Given a machine with dry bearings, the student will identify the type of bearings and choose the appropriate method for lubricating them.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    2. Split bearings
    3. Half bearing
    4. Mult-part bearings
g. Anti-friction bearings
h. Bearing lubrication

## TASK

IPM-43 Identifying oils and their applications

## PERFORMANCE OBJECTIVE

Identify oils and describe their applications.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Oils
    - 1. Load, temperature, speed and environment
    - 2. Animal oils
    - 3. Mineral oils
    - 4. General or special purpose
    - 5. Additives
- b. Oil bases
    - 1. Paraffin-base
    - 2. Napthenic-base
    - 3. Asphaltic-base
    - 4. Mixed base
- c. Equipment
- d. Types of oil lubricants
    - 1. Circulating oils
    - 2. Gear oils
    - 3. Machine engine oils

(Contined on back)

Provide Practical Application On:

Identifying the type of oil for a particular type of machine

## INSTRUCTIONAL MATERIALS

Textbooks:

McGraw-Hill, Standard Handbook of Lubrication Engineering

Student Manuals:

Plant Engineering Training Systems, Lubrication, Lesson Four

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 4 |

**EVALUATION** (IPM-43)

Given specifications for a machine, the student will accurately identify the type of oil used and its application.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    4. Spindle oils
    5. Refrigeration oils
    6. Steam cylinder oils
e. Steel-mill circulating oils
f. Heavy-duty internal combustion engine oils
g. Gear oils
h. Machine and engine oils
    1. Light way oil
    2. Medium way oil
    3. Heavy way oil
i. Spindle oils
j. Refrigeration oils
k. Steam cylinder oils
l. Additional oil applications
    1. Electric motors
    2. Chains
    3. Special purpose oils

## TASK

IPM-44 Identifying general purpose greases

## PERFORMANCE OBJECTIVE

Identify general purpose greases.

## INSTRUCTIONAL ACTIVITIES

**Provide Information On:**

a. Defining greases
    1. Hardness
    2. Dropping point
    3. Pumpability
    4. Water resistance
    5. Stability
b. Elements of grease
    1. Oil
    2. Thickening agent
    3. Additives
c. Characteristics of grease
    1. Base
    2. Dropping point
    3. Penetration
d. Additional characteristics of grease
    1. Texture
    2. Temperature

(Continued on back)

**Provide Practical Application On:**

Identifying several types of greases and describe their applications

## INSTRUCTIONAL MATERIALS

**Textbooks:**

McGraw-Hill, Standard Handbook of Lubrication Engineering

**Student Manuals:**

Plant Engineering Training Systems, Lubrication, Lesson Five

**Tools and Equipment:**

Several types of grease

**LAB HOURS** 2

**CLASS HOURS** 4

## EVALUATION (IPM-44)

Given several types of greases, the student will correctly identify the type of grease and describe its applications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

e. Lubricating action of grease
f. Reasons for using grease
    1. Applications where lubricant can't drip
    2. Inaccessibility of parts
    3. High operating temperatures
    4. Sealing out contaminants
g. How greases are made
    1. Cold made grease
    2. Heating or "cooking"
h. Types of greases
    1. Mixtures of mineral oils and solid materials
    2. Heavy, asphaltic type oils
    3. Extreme pressure greases
    4. Roll-neck greases
    5. Soap-thickened mineral oils
i. Common soaps
    1. Calcium
    2. Sodium
    3. Barium
    4. Lithium
    5. Strontium
    6. Lead
j. Applications
    1. Plain bearing greases
    2. Anti-friction bearings and grease
    3. Bearing re-lubrication

## TASK

IPM-45 Identifying special purpose greases

## PERFORMANCE OBJECTIVE

Identify special purpose greases.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Multipurpose greases
- b. Additives
    - 1. Protecting against chemical change
    - 2. Improving or give new characteristics to a lubricant
    - 3. Protecting the equipment from electrolytic effects
- c. Extreme pressure grease
- d. Water repellent grease
- e. Combined greases
- f. High and low temperature greases
    - 1. Graphite
    - 2. Molybdenum disulfide
- g. Silicone grease
    - 1. Used in high temperature applications
    - 2. Permanently sealed bearings
- h. Dry film lubricants
    - 1. Choosing a dry film lubricant
    - 2. Application

## INSTRUCTIONAL MATERIALS

Textbooks:

McGraw-Hill, Standard Handbook of Lubrication Engineering

Student Manuals:

Plant Engineering Training Systems, Lubrication, Lesson Six

LAB HOURS 2

CLASS HOURS 4

## EVALUATION (IPM-45)

Given an overview of special purpose greases, the student will identify special purpose greases and describe their applicaions.

## TASK

IPM-46 Identifying lubricating compounds

## PERFORMANCE OBJECTIVE

Identify and describe lubricating compounds.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Use of compounds
b. Types of compounds
    1. Natural
    2. Synthetic
c. Liquid lubricants
    1. Petroleum oils
    2. Vegetable oils
    3. Fish oils
d. Petroleum base oils
    1. Paraffin-base
    2. Mapthenic-base
    3. Mixed base
e. Synthetic liquid lubricants
f. Monester
    1. Monobasic acids
    2. Monohydric alcohols
g. Dibasic acid esters
h. Phosphate ester

(Continued on back)

Provide Practical Application On:

Describing the compounds used in various types of oils and greases

## INSTRUCTIONAL MATERIALS

Textbooks:

McGraw-Hill, Standard Handbook of Lubrication Engineering

Student Manuals:

Plant Engineering Training Systems, Lubrication, Lesson Seven

Tools and Equipment:

a. Oils
b. Greases

**LAB HOURS** 0
**CLASS HOURS** 2

**EVALUATION** (IPM-46)

Given an oil or a grease, the student will correctly identify and describe the structure of the compounds.

INSTUCTIONAL ACTIVITIES

Provide Information On:

i. Silicone polymers
j. Silicate esters
k. Solid lubricants
    1. Inorganic
    2. Organic
    3. Metal film lubricants
l. Laminar solids
    1. Graphite
    2. Tungsten disulfide
    3. Mica
    4. Boron nitride
    5. Borax
    6. Cadmium ioxide
m. Soft solids
n. Chemical coatings
    1. Sulfide
    2. Chloride
    3. Oxide
    4. Prosprate
    5. Oxalate
o. Organic compounds
    1. Soaps
    2. Fats
    3. Waxes
p. Polymers

## TASK

IPM-47 Identifying lubrication systems and methods

## PERFORMANCE OBJECTIVE

Identify and describe lubrication systems and methods.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Purpose of a lubrication system
b. Considerations of a lubricating device
    1. Lubricant delivery
    2. Reliability
    3. Overall design
    4. Cost
c. Lubricating delivery
    1. Regulation
    2. Adaptability
    3. Continuity
d. Reliability
    1. Starting and stopping automatically
    2. Purging or clearing itself
e. Cost considerations
    1. Initial cost
    2. Maintenance
    3. Repair
f. Overall design considerations
    1. Space
    2. Safety
    3. Leakage
    4. Number of machines on the system
g. Categories of lubricating methods
    1. Manual
    2, Gravity
    3. Natural
    4. Pressure
h. Pressure lubrication
    1. Dry sump system
    2. Wet sump system
    3. Oil mist system

## INSTRUCTIONAL MATERIALS

Student Manuals:

Plant Engineering Training Systems, Lubrication, Lesson Eight

LAB HOURS 0
CLASS HOURS 3

**EVALUATION** (IPM-47)

Given a machine with a lubricating system, the student will correctly identify the type of lubricating system and describe its operation.

## TASK

IPM-48 Identifying automatic lubrication methods

## PERFORMANCE OBJECTIVE

Identify methods of automatic lubrication.

## INSTRUCTIONAL ACTIVITIES

**Provide Information On:**

a. Automatic lubrication
   1. For oiling
   2. For greasing
b. Oil lubrication
c. Sight glass plow indicators
   1. Tapered
   2. Parallel
   3. Low pressure
   4. Safety
d. Spray valves
e. Metered systems
f. Single-line metering
g. Two-line metering
h. Progression metering

**Provide Practical Application On:**

Identifying the method of automatic lubrication

## INSTRUCTIONAL MATERIALS

**Student Manuals:**

Plant Engineering Training Systems, Lubrication, Lesson Nine

**Tools and Equipment:**

Diagrams of lubricating systems

LAB HOURS 0
CLASS HOURS 2

## EVALUATION (IPM-48)

Given a diagram of an automatic lubricating system, the student will correctly identify the type of system and describe its method of operation.

## TASK

IPM-49 Identifying methods of lubricant storage and handling

## PERFORMANCE OBJECTIVE

Identify methods of storing and handling.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Importance of proper storage
b. General type of storage
    1. Inside
    2. Outside
c. In-plant handling
    1. Drum and tank dispensary
    2. Direct dispensing
d. Inventory and rotating stock
e. Purification and reclamation
f. Gravity separation
    1. Gravity settling
    2. Centrifuges
    3. Strainers
    4. Absorbent filters
g. Safety

Provide Practical Application On:

Describing the appropriate safe handling method for a given lubricant

## INSTRUCTIONAL MATERIALS

Textbooks:

McGraw-Hill, Standard Handbook of Lubrication Engineering

Student Manuals:

Plant Engineering Training Systems, Lubrication, Lesson Ten

Tools and Equipment:

Several types of containers of lubricants

LAB HOURS 2
CLASS HOURS 4

11

**EVALUATION** (IPM-49)

Given a lubricant, the student will correctly identify the appropriate method of storage. The student must adhere to all safety precautions for proper handling of the lubricant.

# TASK

IPM-50 Identifying common couplings

# PERFORMANCE OBJECTIVE

Identify common couplings.

# INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Couplings
b. Coupling requirements
    1. Coupling two rotating shafts
    2. Compensating for shaft misalignment
    3. Allowing axial or end movement of the coupled shafts
    4. Dampening vibrations
    5. Dampening/absorbing torque
    6. Electrical installation
c. Types of misalignment
    1. Parallel
    2. Angular
    3. Combined parallel and angular

(Continued on back)

Provide Practical Application On:

Identifying types of couplings and describing their operations and applications

# INSTRUCTIONAL MATERIALS

Textbooks:

Delmar, Electromechanical Technology Series, Drives

Student Manuals:

Plant Engineering Training Systems, Drive Components, Lesson One

Tools and Equipment:

Examples of several types of couplings

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 4 |

**EVALUATION** (IPM-50)

Given examples of couplings, the student will correctly identify the coupling and describe its operation and application.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

d. Solid couplings
    1. Flanged type
    2. Ribbed
    3. Universal joint
    4. Installing a flanged coupling
e. Jaw couplings
    1. Metal-to-metal contact
    2. Flexible coupling
f. Molded rubber couplings
g. Chain type couplings
h. Gear type couplings
i. Metal disc couplings

## TASK

IPM-51 Identifying special couplings

## PERFORMANCE OBJECTIVE

Identify couplings for special applications.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Coupling requirements
b. Shear pin couplings
c. Torque limiting couplings
d. Brake wheel couplings
e. Floating shaft couplings
f. Spaces couplings
g. Limited end float
h. Electrically insulated couplings
i. Torsionally soft couplings
j. Sheave mounted couplings
k. Continuously lubricated couplings
l. Coupling selection factors
m. Coupling maintenance

Provide Practical Application On:

Determining coupling requirements for a special application

## INSTRUCTIONAL MATERIALS

Textbooks:

Delmar, Electromechanical Technology Series, Drives

Student Manuals:

Plant Engineering Training Systems, Drive Components, Lesson Two

LAB HOURS 0
CLASS HOURS 3

**EVALUATION** (IPM-51)

Given specifications for an application requiring a special purpose coupling, the student will identify an appropriate coupling which meets the requirements of the job and the instructor's specifications.

## TASK

IPM-52 Identifying clutches

## PERFORMANCE OBJECTIVE

Identify clutches.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Comparing clutches and couplings
b. Classes of clutches
    1. Mechanical
    2. Electrical
    3. Hydraulic
c. Jaw clutches
    1. Slow speed applications
    2. Shifting arm
d. Friction clutches
e. Tooth type mechanical clutches
f. Friction type centrifugal clutches
g. Over-running or one way clutches
h. Electric clutches
i. Fluid clutches

Provide Practical Application On:

Determining the type of clutch needed for a given application

## INSTRUCTIONAL MATERIALS

Textbooks:

Delmar, Electromechanical Technology Series, Drives

Student Manuals:

Plant Engineering Training Systems, Clutches, Lesson Three

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 4 |

**[illegible]** (IPM-52)

Given specifications for an application which requires a clutch, the student will identify and describe a clutch. The completed task must meet the instructor's requirements.

## TASK

IPM-53 Identifying V-belt drives

## PERFORMANCE OBJECTIVE

Identify V-belt drives and their applications.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. V-belt drives
b. Belt drive terminology
    1. Driver sheave
    2. Idler sheave
    3. Belt pitch length
    4. Sheave pitch diameter
    5. Arc of contact
    6. Center distance
    7. Speed ratio
c. V-belt types and sizes
    1. Standard
    2. High capacity belts
    3. Light duty V-belts
d. Special V-belts
    1. Double-angle or hex-shaped belts
    2. Group belts
    3. Endless type belts
e. Timing belts

(Continued on back)

Provide Demonstration On:

Installing a V-belt

Provide Practical Application On:

Selecting and installing a V-belt

## INSTRUCTIONAL MATERIALS

Textbooks:

Delmar, Electromechanical Technology Series, Drives

Student Manuals:

Training

Plant Engineering Training Systems, Drive Components, Lesson Four

LAB HOURS 2

CLASS HOURS 4

**EVALUATION** (IPM-53)

Given an assignment to replace a V-belt, the student will select the appropriate type and size of belt and correctly install the belt. The completed task must comply with the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

f. Flat belts
g. V-belt sheaves
h. Timing belt pulleys
i. Flat belt pulleys
j. Variable speed pulleys
k. Manually adjustable sheaves
l. Spring loaded adjustable sheaves
m. V-belt installation

## TASK

IPM-54 Identifying chain drives

## PERFORMANCE OBJECTIVE

Identify chain drives.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Chain drive purpose
b. Chain drive terminology
    1. Driver sprocket
    2. Chain pitch
    3. Center distance
    4. Chain length
    5. Chain rating
    6. Ultimate strength
    7. Pitch diameter
c. Roller chain drives
    1. Applications
    2. ASA roller chain numbers
    3. Construction
    4. Rollerless chains
d. Double-pitch chains
e. Leaf chains
f. Silent chain drives

(Continued on back)

Provide Demonstration On:

Installing a chain on a chain drive system

Provide Practical Application On:

Installing a chain on a chain drive system

## INSTRUCTIONAL MATERIALS

Textbooks:

Delmar, Electromechanical Technology Series, Drives

Student Manuals:

Plant Engineering Training Systems, Drive Components, Lesson Five

LAB HOURS 2

CLASS HOURS 4

**EVALUATION** (IPM-54)

Given a chain drive system, the student will select the appropriate chain and install the chain using procedures specified by the instructor.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

g. Steel drive chains
    1. Straight side bar
    2. Offset side bar
h. Cast chain drives
i. Sprockets
    1. Hub classes
    2. Tapered keyways
    3. Single-duty and double duty sprockets for double pitch chains
j. Installing a chain drive

## TASK

IPM-55 Identifying speed reducers

## PERFORMANCE OBJECTIVE

Identify speed reducers.

## INSTRUCTIONAL ACTIVITIES

**Provide Information On:**

a. Speed reducers
b. Reducer terminology
    1. Size
    2. Mechanical horsepower
    3. Thermal horsepower
    4. Overload capacity
    5. Service factor
    6. Gear ratio
    7. Single reduction units
    8. Double reduction units
    9. Triple reduction units
c. Concentric shaft reducers
    1. Mounted integrally with motor
    2. Helical cut gears
    3. Spur gears
    4. Planetary gears
d. Bearing support

(Continued on back)

**Provide Demonstration On:**

Installing a reducer

**Provide Practical Application On:**

Installing a reducer

## INSTRUCTIONAL MATERIALS

**Textbooks:**

Delmar, *Electromechanical Technology Series, Drives*

**Student Manuals:**

a. Plant Engineering Training Systems, *Drive Components, Lesson Six*
b. Plant Engineering Training Systems, *Drive Components, Lesson Seven*

**LAB HOURS** 2
**CLASS HOURS** 4

**EVALUATION** (IPM-55)

Given a drive system requiring a reducer, the student will select and install the appropriate reducer according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    1. Snap ring
    2. Short shoulders
    3. Locking plates
    4. Oil seals
e. Parallel shaft reducers
f. Right angle shaft reducers
    1. Gearing
    2. Applications
g. Vertical shaft reducers
h. Types of speed reducers
    1. Shaft mounted
    2. Worm gear reducers
    3. Miter boxes
i. Installing a reducer
j. Reducer maintenance

## TASK

IPM-56 Identifying gears

## PERFORMANCE OBJECTIVE

Identify gears.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Gear drives
b. Gear terminology
    1. Pitch diameter
    2. Diametral pitch
    3. Outside diameter
    4. Pressure angle
    5. Circular pitch
    6. Chordal thickness
    7. Addendum
    8. Dedendum
    9. Whole depth
    10. Working depth
    11. Face width
    12. Face of tooth
    13. Flank of tooth
    14. Back lash
c. Spur gears

(Continued on back)

Provide Demonstration On:

Installing gears

Provide Practical Application On:

Installing gears on a drive system

## INSTRUCTIONAL MATERIALS

Textbooks:

Delmar, Electromechanical Technology Series, Drives

Student Manuals:

Plant Engineering Training Systems, Drive Components, Lesson Eight

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 4 |

## EVALUATION (IPM-56)

Given a drive system and specifications, the student will select the appropriate gears and install the gears using correct procedures.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

d. Helical gears
    1. Helix angle
    2. Linear circular pitch
    3. Linear tooth thickness
    4. Linear pressure angle
e. Herringbone gears
f. Bevel gears
g. Worm gears
    1. Gear pitch diameters
    2. Worm pitch diameters
    3. Worm lead angle
    4. Worm lead
    5. Normal worm pitch
    6. Worm axial pitch
    7. Normal pressure angle
h. Gear maintenance

## TASK

IPM-57 Identifying variable speed reducers

## PERFORMANCE OBJECTIVE

Identify variable speed reducers.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Variable speed reducers
   1. Applications
   2. Mechanical and electrical types
   3. Selection factors
b. Belt type variable speed drives
   1. Construction
   2. Operation
   3. Adjustment methods
   4. Belt types
c. Disc type variable speed drives
d. Roller type variable speed drives
e. Hydraulic variable speed drives
f. Electric variable speed drives

## INSTRUCTIONAL MATERIALS

Textbooks:

Delmar, Electromechanical Technology Series, Drives

Student Manuals:

Plant Engineering Training Systems, Drive Components, Lesson Nine

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 4 |

## EVALUATION (IPM-57)

Given a drive system and specifications, the student will select a variable speed drive for the system. The selection must meet the instructor's specifications.

## TASK

IPM-58 Identifying brakes and motors

## PERFORMANCE OBJECTIVE

Identify brakes and motors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Brakes and motors
b. Brakes
    1. Externally mounted
    2. Internally mounted
c. Friction shoe brakes
    1. Brake wheel coupling
    2. Construction
    3. Operation
d. Friction disc brakes
    1. Electrically operated
    2. Mounting
e. Magnetic brakes
    1. Types
    2. Applications
    3. Reversing starter
f. Motors
    1. A-C
    2. D-C

(Continued on back)

Provide Demonstration On:

Lubricating and cleaning a motor

Provide Practical Application On:

Lubricating and cleaning an electric motor

## INSTRUCTIONAL MATERIALS

Textbooks:

Delmar, Electromechanical Technology Series, Drives

Student Manuals:

Plant Engineering Training Systems, Drive Components, Lesson Ten

**LAB HOURS** 10

**CLASS HOURS** 13

## EVALUATION (IPM-58)

Given a drive system which has a motor and a brake, the student will identify and correctly describe the type of motor, brake and their operations.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

g. D-C motor types
    1. Shunt
    2. Series
    3. Compound wound
    4. Parts
h. A-C motor types
    1. Induction
    2. Synchronous
    3. Single-phase
    4. Multi-phase
    5. Polyphase
    6. Split-phase
    7. Capacitor start
i. Motor classification
j. Motor maintenance
    1. Lubrication
    2. Cleanliness

## TASK

IPM-59 Identifying principles of bearings and shafts

## PERFORMANCE OBJECTIVE

Identify basic principles of bearings and shafts.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Bearing selection
   1. Bearing
   2. Spindle
   3. Factors in selection
b. Shafts and shafting
c. Shaft materials
d. Shaft stress
e. Other forces
f. Fits and clearances
g. Principles of bearing operation
h. Types of bearings

## INSTRUCTIONAL MATERIALS

Textbooks:

McGraw-Hill, Maintenance Engineering Handbook

Student Manuals:

Plant Engineering Training Systems, Bearings, Lesson One

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 7 |

## EVALUATION (IPM-59)

Given instruction in the basic principles of bearings and shafts, the student will correctly identify factors critical in making the selection for given applications.

## TASK

IPM-60 Identifying plain journal bearings

## PERFORMANCE OBJECTIVE

Identify plain journal bearings.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Plain journal bearings
b. Advantages of plain journal bearings
c. Lubrication
d. Lubricating grooves
e. Seals
f. Types of plain journal bearings
g. Bearing design and selection
h. Characteristics of bearings
i. Bearing meterials
j. Inspection of bearings
k. Bearing repair
l. Relining
m. Disassembly and reconditioning
n. Bearing installation

Provide Demonstration On:

a. Reconditioning a bearing
b. Installing a bearing

Provide Practical Application On:

Reconditioning a bearing and installing it

## INSTRUCTIONAL MATERIALS

Textbooks:

McGraw-Hill, Maintenance Engineering Handbook

Student Manuals:

a. Plant Engineering Training Systems, Bearings, Lesson Two
b. Plant Engineering Training Systems, Bearings, Lesson Three

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 4 |

## EVALUATION (IPM-60)

Given a plain journal bearing which is worn, the student will pull, recondition, re-groove and re-install the bearing. The completed work must comply with the instructor's specifications.

## TASK

IPM-61 Identifying anti-friction bearings

## PERFORMANCE OBJECTIVE

Identify anti-friction bearings.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Anti-friction bearings
b. Operating principles
c. Bearing materials
d. Cage materials
e. Lubrication of anti-friction bearings
f. Seals and shields
g. Bearing classifications
h. Tolerances
i. Standard and precision bearings
j. Running accuracy
k. Bearing fits
l. Bearing design
m. Radial and axial
n. Fixed and floating bearings
o. Bearing fits
p. Squareness and alignment

(Continued on back)

Provide Practical Application On:

Selecting the appropriate anti-friction bearing for a specified application

## INSTRUCTIONAL MATERIALS

Textbooks:

McGraw-Hill, Maintenance Engineering Handbook

Student Manuals:

a. Plant Engineering Training Systems, Bearings, Lesson Four
b. Plant Engineering Training Systems, Bearings, Lesson Five

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 4 |

**EVALUATION** (IPM-61)

Given specifications for an application requiring anti-friction bearings, the student will accurately select the appropriate size and type of bearing.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

q. Mounting methods
r. Mountings
s. Bearing selection

143

## TASK

IPM-62 Identifying ball and roller bearings

## PERFORMANCE OBJECTIVE

Identify ball and roller bearings.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Difference between ball and roller bearings
b. Advantages over plain bearings
c. Ball bearings
d. Other types
e. Two-piece, inner-ring bearings
f. Fractured bearings
g. Bearing series
h. Roller bearings
i. Needle roller bearings

## INSTRUCTIONAL MATERIALS

Textbooks:

McGraw-Hill, Maintenance Engineering Handbook

Student Manuals:

Plant Engineering Training Systems, Bearings, Lesson Six

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 4 |

## EVALUATION (IPM-62)

Given an overview of ball and roller bearing applications, the student will identify types of ball and roller bearings and describe their applications. The identification must comply with instructor's requirements.

## TASK

IPM-63 Identifying specialized bearings

## PERFORMANCE OBJECTIVE

Identify specialized bearings.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Thrust bearings
b. Self-aligning bearings
c. Linear-motion bearings
d. Pre-mounted bearings
e. Instrument bearings
f. Unground ball bearings
g. Powdered-metal bearings
h. Non-metallic bearings
i. Other materials
j. Hydrostatic bearings

## INSTRUCTIONAL MATERIALS

| Textbooks: | Student Manuals: |
|---|---|
| McGraw-Hill, Maintenance Engineering Handbook | Plant Engineering Training Systems, Bearings, Lesson Seven |

LAB HOURS 2
CLASS HOURS 4

## EVALUATION (IPM-63)

Given specifications for a special bearing application, the student will accurately identify and describe the type of bearing required.

## TASK

IPM-64 Identifying bearing seals

## PERFORMANCE OBJECTIVE

Identify bearing seals.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Purpose of seals
b. Seal functions
c. Styles and types
d. Labyrinth seals
e. Oil seals
f. Oil seal classification
g. Special seals
h. Seal selection
i. Seal applications
j. "O" rings and mechanical seals

## INSTRUCTIONAL MATERIALS

Textbooks:

McGraw-Hill, Maintenance Engineering Handbook

Student Manuals:

Plant Engineering Training Systems, Bearings, Lesson Eight

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 4 |

## EVALUATION (IPM-64)

Given specifications for a seal application, the student will correctly identify the type of seal to use.

## TASK

IPM-65 Identifying methods of bearing lubrication

## PERFORMANCE OBJECTIVE

Identify methods of lubricating bearings.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Lubrication practices
b. Functions of a lubricant
c. Lubricant selection factors
d. Oil lubrication
e. Grease lubrication
f. Special purpose
g. Packing bearings
h. Lubrication equipment

## INSTRUCTIONAL MATERIALS

Textbooks:

McGraw-Hill, Maintenance Engineering Handbook

Student Manuals:

Plant Engineering Training Systems, Bearings, Lesson Nine

**LAB HOURS** 5
**CLASS HOURS** 5

**EVALUATION** (IPM-65)

Given specifications for bearings which require lubrication, the student will accurately identify the appropriate method of lubrication.

## TASK

IPM-66 Maintaining bearings

## PERFORMANCE OBJECTIVE

Maintain bearings.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Bearing maintenance
b. Installing plain journal bearings
c. Installing anti-friction bearings
d. Mounting a bearing
e. Removing a bearing
f. Bearing loading patterns
g. Bearing failure
h. Cleaning a bearing

Provide Demonstration On:

a. Mounting a bearing
b. Removing a bearing
c. Cleaning a bearing

Providing Practical Application On:

a. Pulling a bearing, cleaning and mounting it
b. Testing the machine for proper operating

## INSTRUCTIONAL MATERIALS

Textbooks:

McGraw-Hill, Maintenance Engineering Handbook

Student Manuals:

Plant Engineering Training Systems, Bearings, Lesson Ten

| | |
|---|---|
| LAB HOURS | 14 |
| CLASS HOURS | 10 |

## EVALUATION (IPM-66)

Given a machine with faulty bearings, the student will correctly identify the fault and pull, clean and replace the bearing. The bearing must be properly aligned and meet all industry requirements.

## TASK

IPM-67 Identifying pump application

## PERFORMANCE OBJECTIVE

Identifying applications of pumps.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Water pumping systems
  1. Direct type
  2. Recirculating
b. Chemical pumping systems
c. Waste handling systems
d. High viscosity material pumping systems
e. Solids pumping system

Provide Practical Application On:

Identifying the type of pumping system required for a specified material

## INSTRUCTIONAL MATERIALS

Textbooks:

Howard W. Sams and Co., Inc., Pumps

Student Manuals:

Plant Engineering Training Systems, Pumps, Lesson One

| | |
|---|---|
| LAB HOURS | 0 |
| CLASS HOURS | 2 |

## EVALUATION (IPM-67)

Given a specified substance to pump, the student will accurately identify and describe the type of pumping system required to efficiently pump the given substance.

## TASK

IPM-68 Selecting a pump

## PERFORMANCE OBJECTIVE

Select the appropriate pump for a system.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Pump problems
   1. Packings
   2. Seals
   3. Bearings
   4. Leaks

b. Pump terminology
   1. Suction lift
   2. Static suction lift
   3. Total dynamic suction lift
   4. Velocity head
   5. Suction head
   6. Static suction head
   7. Total dynamic

c. Pump terminology discharge side
   1. Total static head
   2. Total dynamic head

(Continued on back)

Provide Practical Application On:

Selecting a pump for a specified system

## INSTRUCTIONAL MATERIALS

Textbooks:

Black, Pumps

Student Manuals:

Plant Engineering Training Systems, Pumps, Lesson Two

| | |
|---|---|
| LAB HOURS | 0 |
| CLASS HOURS | 2 |

## EVALUATION (IPM-68)

Given specifications for a system, the student will select a pump that has adequate capacity and speed to pump the substance. The instructor will check the student's choice.

## TASK

IPM-69 Identifying centrifugal pumps

## PERFORMANCE OBJECTIVE

Identify centrifugal pumps.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Centrifugal pump applications
    1. Water or light fluid
    2. Can be adapted for heavy materials
b. Pump operation
c. Pump parts
    1. Casing
    2. Shaft
    3. Impeller
    4. Impeller vanes
    5. Impeller shrouds
    6. Pump suction
    7. Wearing rings
    8. A packing gland
    9. Diffusers
    10. Discharge point
d. Multi-stage pumps

(Continued on back)

Provide Practical Application On:

Identifying the parts of a centrifugal pump and describing how it operates

## INSTRUCTIONAL MATERIALS

Textbooks:

Black, Pumps

Student Manuals:

Plant Engineering Training Systems, Pumps, Lesson Three

Tools and Equipment:

Centrifugal pumps and parts

| | |
|---|---|
| LAB HOURS | 0 |
| CLASS HOURS | 2 |

## EVALUATION (IPM-69)

Given a centrifugal pump, the student will identify the type of pump and correctly name the pump parts and their functions.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

e. Pump casings
f. Impellers
g. Wearing rings
h. Shafts

## TASK

IPM-70 Identifying propeller and turbine pumps

## PERFORMANCE OBJECTIVE

Identify a propeller or turbine pump.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Propeller pumps
b. Axial-flow pumps
  1. Application
  2. Above or below grade discharge points
  3. Diffuser vanes
  4. Steady bearings
c. Construction of propeller pumps
d. Mixed flow pumps
  1. Centrifugal errosion of water
  2. Operating speeds
  3. Enclosed vanes
  4. Casing size
e. Special propeller pump applications
  1. Location above water surface

(Continued on back)

Provide Practical Application:

Identifying the type of turbine or propeller pump and determining the direction of the flow

## INSTRUCTIONAL MATERIALS

Textbooks:

Black, Pumps

Student Manuals:

Plant Engineering Training Systems, Pumps, Lesson Four

**LAB HOURS** 0

**CLASS HOURS** 2

## EVALUATION (IPM-70)

Given a system with a turbine or propeller pump, the student will accurately identify the type of pump and determine the direction of flow according to the instructor's satisfaction.

### INSTRUCTIONAL ACTIVITIES

Provide Information On:

    2. Large sump pump applications
f. Vertical turbine pump
    1. Applications
    2. Construction
g. Horizontal turbine pumps
    1. Regenerative pumps
    2. Applications
    3. Construction
    4. Relief valves

161

## TASK

IPM-71 Identifying rotary pumps

## PERFORMANCE OBJECTIVE

Identify rotary pumps.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Rotary pumps
   1. Purpose
   2. Operation
b. External gear pumps
   1. Operation
   2. Gear types
   3. Construction
c. Internal gear pumps
   1. Outer gear
   2. Internal gear
   3. Crescent
d. Helical screw gear pumps
   1. Operation
   2. Construction
e. Vane type pumps
   1. Application
   2. Construction
f. Flexible impeller pumps

(Contined on back)

Provide Demonstration On:

Installing a rotary pump

Provide Practical Application On:

Installing a rotary pump on a system

## INSTRUCTIONAL MATERIALS

Textbooks:

Black, Pumps

Student Manuals:

Plant Engineering Training Systems, Pumps, Lesson Five

Tools and Equipment:

a. Rotary pump
b. Mounting hardware
c. Wrenches, screwdrivers and related tools

**LAB HOURS** 0

**CLASS HOURS** 2

**EVALUATION** (IPM-71)

Given specifications for a job, the student will select and install the appropriate rotary pump on a system. The completed work must comply with the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    1. Used for chemical applications
    2. Construction
g. Installing a rotary pump

## TASK

IPM-72 Identifying reciprocating pumps

## PERFORMANCE OBJECTIVE

Identify reciprocating pumps.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Reciprocating pump application
    1. Steam driven
    2. Pneumatic pumps
b. Terminology
    1. Liquid section
    2. Steam on air section
    3. Piston and piston ring
    4. Cylinder
    5. Cylinder head
    6. Packing gland
    7. Connecting rod
    8. Valves
    9. Simplex pump
    10. Duplex pump
    11. Single-acting pump
    12. Double-acting pump
    13. Triplex pump

(Continued on back)

Provide Demonstration On:

Calculating pump flow in gpm

Provide Practical Application On:

Calculating the flow of a pump in gallons per minute (GPM)

## INSTRUCTIONAL MATERIALS

Textbooks:

Black, Pumps

Student Manuals:

Plant Engineering Training Systems, Pumps, Lesson Six

| | |
|---|---|
| LAB HOURS | 0 |
| CLASS HOURS | 2 |

## EVALUATION (IPM-72)

Given a reciprocating pump, the student will calculate the rate of flow of the pump in gallons per minute (GPM). The completed task must comply with the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

C. Calculating pump flow
d. Steam-driven pumps
e. Pumping section
    1. Valve plate
    2. Pot valve
    3. Renewable cylinder liners
f. Driving section
g. Rotary driven reciprocating pumps
    1. Power source
    2. Capacity
h. Horizontal plunger pumps
i. Vertical plunger pumps
j. Air driven pumps
k. Fluid section
l. Air sections

## TASK

IPM-73 Identifying metering pumps

## PERFORMANCE OBJECTIVE

Identify metering pumps.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Metering pump requirements
    1. Sensitivity to temperature
    2. Protection from internal damage
    3. Tolerances
b. Metering pump classifications
    1. Plunger (or piston)
    2. Diaphragm
    3. Rotary
    4. Air cylinder operated
c. Plunger pumps
    1. Applications
    2. Construction
    3. Metering adjustments
    4. Types of plunger pumps
d. Diaphragm pumps

(Continued on back)

Provide Practical Application On:

Identifying a metering pump as to the type and describe its operation

## INSTRUCTIONAL MATERIALS

Textbooks:

Black, Pumps

Student Manuals:

Plant Engineering Training Systems, Pumps, Lesson Seven

Tools and Equipment:

Several types of metering pumps

| | |
|---|---|
| LAB HOURS | 0 |
| CLASS HOURS | 2 |

## **EVALUATION** (IPM-73)

Given a metering pump, the student will accurately identify the pump and describe its operation.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    1. Operation
    2. Methods of adjustment
    3. Types
e. Rotary metering pumps
    1. Construction
    2. Method of metering flow
    3. Types
f. Air cylinder-operated metering pumps
    1. Construction
    2. Operation
    3. Control mechanisms

## TASK

IPM-74 Identifying special purpose pumps

## PERFORMANCE OBJECTIVE

Identify special purpose pumps.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Handling difficult materials
- b. Chemical pumps
- c. Peristaltic pumps
    - 1. Tube peristaltic pumps
    - 2. Peristaltic screw pumps
    - 3. Applications
- d. Non-sealing chemical pumps
- e. Slurry pumps
- f. Pulp handling pumps
- g. Trash and sewage pumps
- h. Diaphragm pump
    - 1. Operation
    - 2. Applications
- i. Reciprocating slurry pumps
    - 1. Air or steam operated
    - 2. Motor or engine driven

Provide Practical Application On:

Determining the type of pump to use for a special purpose application

## INSTRUCTIONAL MATERIALS

Textbooks:

Black, Pumps

Student Manuals:

Plant Engineering Training Systems, Pumps, Lesson Eight

**LAB HOURS** 0

**CLASS HOURS** 2

## **EVALUATION** (IPM-74)

Given specifications for a special purpose pumping job, the student will accurately identify the type of pump and the special requirements for its operation.

## TASK

IPM-75 Installing packings and maintaining pumps seals

## PERFORMANCE OBJECTIVE

Install packing and maintain seals on a pump.

## INSTRUCTIONAL ACTIVITIES

**Provide Information On:**

a. Packing or seal requirements
b. Types of packing glands
    1. Solid packed stuffing box
    2. Sealing or injection type
    3. Internally or externally sealed
    4. Seal-ring cage
    5. Circulating packing gland
    6. Bleed-off gland
    7. Injection bleed off
    8. Smothering gland
c. Packing materials
    1. Cotton
    2. Asbestos

(Continued on back)

**Provide Practical Application On:**

Installing packing in a pump

## INSTRUCTIONAL MATERIALS

**Textbooks:**

Black, *Pumps*

**Student Manuals:**

Plant Engineering Training Systems, *Pumps, Lesson Nine*

LAB HOURS 2
CLASS HOURS 3

**EVALUATION** (IPM-75)

Given a pump which requires replacement of packing or seal maintenance, the student will correctly install packing or maintain a seal according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    3. Flax
    4. Aluminum and babbitt
       (for higher temperature)
    5. Synthetic types
d. Installing packing
e. Mechanical seals
    1. Rotating members
    2. Stationary members
    3. Construction: cartridge
       or separate
    4. Internal and external
       seals
    5. Balanced or unbalanced
f. Special seals
    1. Packingless seal
    2. Floating ring seal

## TASK

IPM-76 Performing pump maintenance

## PERFORMANCE OBJECTIVE

Perform pump maintenance.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Pump bearings
b. Journal bearings
c. Anti-friction bearings
d. Special bearings
e. Bearing lubrication
    1. Regular lubrication
    2. Using the proper lubricant
    3. Methods of lubrication
f. Bearing seals
g. Pump installation
h. Pump maintenance
i. Maintenance of centrifugal pumps
j. Maintenance of vertical turbine pumps
k. Rotary pump maintenance

(Continued on back)

Provide Practical Application On:

Identifying and performing maintenance on a pump

## INSTRUCTIONAL MATERIALS

Textbooks:

Black, Pumps

Student Manuals:

Plant Engineering Training Systems, Pumps, Lesson Ten

| | |
|---|---|
| LAB HOURS | 3 |
| CLASS HOURS | 0 |

**EVALUATION** (IPM-76)

Given a pumping system, the student will correctly identify and perform all maintenance required on the pumps and related parts. The completed task must comply with the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

l. Maintenance of difficult material pumps
m. Maintenance problems other than pump related

## TASK

IPM-77 Identifying piping systems and piping system maintenance

## PERFORMANCE OBJECTIVE

Identify piping systems and related maintenance requirements.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Piping systems
    1. Purpose of piping system
    2. Types of piping systems
b. Fluids
c. Purpose of components
    1. Fluids moving
    2. Fluids in good condition
d. Maintenance
    1. Blow-off valves
    2. Clean out plugs
e. Valves and fittings
f. Pipe hanging and support
g. Temperature effects
h. Piping insulation

(Continued on back)

Provide Practical Application On:

Inspecting a piping system and performing routine maintenance as necessary

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Audel, Plumbers and Pipefitter's Library
b. ATS, How to Design and Install Plumbing

Student Manuals:

Plant Egnineering Training Systems, Piping Systems, Lesson One

Tools and Equipment:

Pipefitter's tools

LAB HOURS 0
CLASS HOURS 2

## EVALUATION (IPM-77)

Given a piping system, the student will inspect the system and perform routine maintenance as necessary. The completed task must comply with the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

i. Maintenance considerations of piping systems
   1. Corrosion and leakage
   2. Valves
   3. Insulation
   4. Installing new piping, tubing, hoses
   5. Fittings
   6. Hangers and pipe supports
   7. Cleaning pipe
   8. Extending existing system as needed

## TASK

IPM-78 Maintaining metal pipe

## PERFORMANCE OBJECTIVE

Maintain metal pipe on a piping system.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Pipes
    1. Outside diameter
    2. Inside diameter
    3. Wall thickness
    4. Length
    5. Weight per foot
b. Pipe schedules
    1. Standard
    2. Extra-strong
    3. Double extra-strong
c. Other pipe codes
d. Types of system
    1. Process lines
    2. Utility or service lines
e. Identification of pipe lines
    1. Color

(Continued on back)

Provide Demonstration On:

Threading pipe

Provide Practical Application On:

Choosing the proper size pipe and threading the pipe to replace a section

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Audel, Plumber's and Pipefitter's Library
b. ATS, How to Design and Install Plumbing

A/Vs:

Hobar, "Basic Plumbing Skills," filmstrip

Student Manuals:

Plant Engineering Training Systems, Piping Systems, Lesson Two

Tools and Equipment:

a. Pipe
b. Dies
c. Wire brush
d. Pipe compound or "dope"

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 0 |

## EVALUATION (IPM-78)

Given a piping system, the student will select the appropriate size pipe, thread the pipe and replace the section according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    2. Stenciled or painted letters
    3. Tags or nameplates
f. Metal piping
g. Characteristics of metals
h. Pipe manufacturing methods
i. Behavior of fluids in piping
j. Piping applications
k. Steam piping
l. Water piping
m. Maintenance considerations
    1. Effects of temperature changes
    2. Outside material in the lines
    3. Shifting of pipe supports
    4. Corrosion
    5. Water hammer
n. Joining pipe
    1. Bell and spigot
    2. Welded
    3. Soldered or brazed
    4. Screwed
    5. Forged

## TASK

IPM-79 Maintaining non-metallic piping

## PERFORMANCE OBJECTIVE

Maintain non-metallic piping.

## INSTRUCTIONAL ACTIVITIES

**Provide Information On:**

a. Types of non-metallic pipe
   1. Clay
   2. Concrete
   3. Plastic
   4. Glass
   5. Wood

b. Clay pipe
   1. Vitrified
   2. Unglazed

c. Concrete pipe
   1. Non-reinforced concrete
   2. Reinforced concrete
   3. Reinforced and prestressed concrete pressure pipe - cylinder pipe
   4. Asbestos - cement pipe

(Continued on back)

**Provide Demonstration On:**

Joining plastic pipe by solvent welding

**Provide Practical Application On:**

Using solvent, replace a section plastic pipe by solvent welding

## INSTRUCTIONAL MATERIALS

**Textbooks:**

a. Audel, Plumber's and Pipefitter's Library
b. ATS, How to Design and Install Plumbing

**A/Vs:**

Hobar, "Laboratory Exercises in Pipefitting," slide/tape

**Student Manuals:**

Plant Engineering Training Systems, Piping Systems, Lesson Three

**Tools and Equipment:**

a. PUC, ASB or CAB pipe
b. Solvent
c. Brush
d. Sandpaper

**LAB HOURS** 2

**CLASS HOURS** 0

## EVALUATION (IPM-79)

Given a piping system requiring a section replacement, the student will join a new section of piping using the appropriate solvent. The completed task must comply with the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

c. Plastic piping
   1. High corrosion resistance
   2. Self-insulating
   3. Freedom from rust and rot
   4. Lightweight
   5. Ease of joining
d. Thermoplastic piping
   1. PUC (polyethylene chloride)
   2. PEC (polyethylene)
   3. ABS (acrylonitrile - butadine - styrene)
   4. CAB (cellulose - acetate - butyrate)
e. Thermosetting plastics
   1. Epoxy piping
   2. Polyester piping
f. Limitations of plastic piping
g. Joining plastic piping
h. Plastic piping maintenance
i. Glass piping
j. Other piping materials
   1. Chemical procelain
   2. Chemical stoneware
   3. Wooden pipe
   4. Cast iron and steel

## TASK

IPM-80 Maintaining tubing

## PERFORMANCE OBJECTIVE

Maintain tubing.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Tubing
   1. Classifying tubing
   2. Birmingham Wire Gage (BWG)
   3. Tubing applications

b. Advantages of tubing
   1. Tight spaces
   2. Flexibility
   3. Laminar flow

c. Joining tubing

d. Types of tubing
   1. Copper
   2. Steel
   3. Stainless steel
   4. Aluminum

e. Tubing applications

f. Plastic tubing

g. Tubing maintenance

Provide Demonstration On:

a. Bending tubing
b. Soldering tubing

Provide Practical Application On:

Bending tubing and soldering a joint

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Audel, Plumber's and Pipefitter's Library
b. ATS, How to Design and Install Plumbing

A/Vs:

Hobar, "Laboratory Exercises in Pipe Fitting," slide/tape

Student Manuals:

Plant Engineering Training Systems, Piping Systems, Lesson Four

Tools and Equipment:

a. Tubing
b. Tube cutter
c. Deburring tool
d. Wire brush or emery cloth
e. Flaring tool

(Continued on back)

LAB HOURS 2

CLASS HOURS 0

## EVALUATION (IPM-80)

Given a piping system requiring a section of copper tubing, the student will follow appropriate procedures to bend and solder the tubing joints to lengths and bends. All work must comply with the instructor's specifications.

### INSTRUCTIONAL MATERIALS

Tools and Equipment:

f. Solder
g. Torch
h. Tube bender
i. Flux

## TASK

IPM-81 Maintaining hoses

## PERFORMANCE OBJECTIVE

Maintain hoses.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Hoses
    1. Applications
    2. Vibration dampening effect
b. Codes and sizes
c. Hose classifications
    1. Non-metallic
    2. Non-metallic reinforced
    3. Metallic
d. Hose terminology
    1. Enlarge or expanded
    2. Tube
    3. Reinforcement
    4. Mandrel braided
    5. Cover
    6. Overall length
    7. Vacuum rating

(Continued on back)

Provide Demonstration On:

Installing coupling on hoses

Provide Practical Application On:

Installing a coupling and joining a piece of hose to a piping system

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Audel, Plumber's and Pipefitter's Library
b. ATS, How to Design and Install Plumbing

Student Manuals:

Plant Engineering Training Systems, Piping Systems, Lesson Five

Tools and Equipment:

a. Hoses
b. Couplings
c. Pliers
d. Clamps

LAB HOURS 2

CLASS HOURS 0

**EVALUATION** (IPM-81)

Given a piping system, the student will select the proper size hose, install a coupling and install the hose in the system according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

e. Non-metallic - reinforced hose
    1. Vertical and horizontal braiding
    2. Horizontal braided - wire reinforced
    3. Wrapped hose
    4. Wire reinforced
    5. Wire woven
f. Non-metallic hose
g. Metallic hoses
    1. Bronze braided
    2. Applications
h. Hose couplings
    1. Anchor coupling
    2. Clamping
    3. Guide disconnect
i. Maintanance of hoses

## TASK

IPM-82 Maintaining fittings

## PERFORMANCE OBJECTIVE

Maintain fittings.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Fittings
   1. Steel, bronze, cast iron, plastic, glass
   2. Standards

b. Functions of fittings
   1. Changing direction of flow
   2. Providing branch connections
   3. Changing size of lines
   4. Close lines

c. Connecting fittings
   1. Screwed
   2. Flanged
   3. Welded

d. Other fittings
   1. Expansion joints

(Continued on back)

Provide Practical Application On:

Choosing a fitting and correctly connecting tubing

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Audel, Plumber's and Pipefitter's Library
b. ATS, How to Design and Install Plumbing

A/Vs:

Hobar, "Laboratory Exercise in Pipefitting," slide/tape

Student Manuals:

Plant Engineering Training Systems, Piping Systems, Lesson Six

Tools and Equipment:

a. Tubings
b. Fittings
c. Flaring tool
d. Wrenches

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 0 |

## EVALUATION (IPM-82)

Given tubing which requires connection, the student will choose the appropriate fitting and correctly connect the tubing. Work must comply with the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    2. Vibration dampeners
e. Welding fittings
f. Tubing fittings
    1. Flared
    2. Compression
    3. Brazed-seal tube

## TASK

IPM-83 Maintaining common valves

## PERFORMANCE OBJECTIVE

Maintain common valves.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Valves
    1. Purpose
    2. Construction
    3. Sizes
b. Valve functions
    1. Throttling
    2. Regulating
c. Types of industrial valves
    1. Ball
    2. Globe
    3. Gate
    4. Butterfly
    5. Plug
    6. Needle
    7. Check
    8. Quick-opening
d. Parts of a valve
    1. Body

(Continued on back)

Provide Demonstration On:

Replacing seals in a valve

Provide Practical Application On:

Replacing seals in a valve

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Audel, *Plumber's and Pipefitter's Library*
b. ATS, *How to Design and Install Plumbing*

A/Vs:

Hobar, "Laboratory Exercises in Pipefitting," slide/tape

Student Manuals:

Plant Engineering Training System, *Piping Systems*, *Lesson Seven*

Tools and Equipment:

a. Seals
b. Valves
c. Wrenches

**LAB HOURS** 2

**CLASS HOURS** 0

## EVALUATION (IPM-83)

Given a leaky valve, the student will disassemble the valve, replace the appropriate seals and reassemble the valve. The completed task must be free of leaks and within instuctor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    2. Bonnet
    3. Trim
e. Types of check valves
    1. Horizontal list
    2. Vertical list
    3. Ball check
    4. Foot valve
    5. Swing check
f. Valve maintenance
    1. Galling
    2. Seizing
    3. Leaks
g. Valve connections

## TASK

IPM-84 Identifying specialized valves

## PERFORMANCE OBJECTIVE

Identify specialized valves.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Construction and materials
b. Diaphragm valves
c. Blowoff valves
    1. Using boiler pressure to blow off boiler water
    2. Lowering water level in boiler
    3. Clearing the boiler after cleaning
    4. Types - seatless sliding plunger, sliding disc, seat-and-disc
d. Pressure regulator valves
    1. Main valve and piston assembly
    2. Auxiliary valve assembly
e. Temperature regulating valves
f. Safety valves
g. Relief valves
    1. Rupture disc relief valves
    2. Pressure reducing valves
h. Other valve types
    1. By-pass valves
    2. Float valve
    3. Pilot valve
    4. Slurry valve
i. Valve operators
    1. Actuators
    2. Operators
    3. Magnetic operators
    4. Pneumatic and hydraulic operators
    5. Remote control

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Audel, Plumber's and Pipefitter's Library
b. ATS, How to Design and Install Plumbing

Student Manuals:

Plant Engineering Training Systems, Piping Systems, Lesson Eight

LAB HOURS 0
CLASS HOURS 1

## EVALUATION (IPM-84)

Given a piping system, the student will accurately identify specialized valves used in the system and describe their purposes.

189

## TASK

IPM-85 Maintaining strainers, filters and traps

## PERFORMANCE OBJECTIVE

Maintain strainers, filters and traps.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Strainers
    1. Construction
    2. Uses
b. Magnetic ferrous trap
c. Filters
    1. Change fluid direction and trap contaminants
    2. Duplex filter
    3. Edge-type filter
    4. Cartridge-type filter
d. Steam
e. Traps
    1. Purpose
    2. Thermostatic traps
    3. Mechanical traps
f. Mechanical traps
    1. Float-and-thermostatic
    2. Float

(Continued on back)

Provide Demonstration On:

Troubleshooting a faulty trap

Provide Practical Application On:

Troubleshooting and repairing a faulty trap

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Audel, Plumber's and Pipefitter's Library
b. ATS, How to Design and Install Plumbing

A/Vs:

Hobar, "Laboratory Exercises in Pipefitting," slide/tape

Student Manuals:

Plant Engineering Training Systems, Piping Systems, Lesson Nine

Tools and Equipment:

a. Wrenches
b. Protective gloves

LAB HOURS 3

CLASS HOURS 2

**EVALUATION** (IPM-85)

Given a piping system with a defective trap, the student will troubleshoot the trap and accurately correct the defect. The student must observe all safety requirements and the completed work must comply with the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    3. Inverted bucket
    4. Upright bucket
g. Vent valves
    1. Purpose
    2. Vacuum vent valve
h. Trap maintenance
    1. Removing sludge
    2. Adjusting mechanical linkage
    3. Reseating valves
    4. Troubleshooting a faulty trap
    5. Safety

## TASK

IPM-86 Maintaining pipeline by monitoring accessories

## PERFORMANCE OBJECTIVE

Maintain pipeline by monitoring accessories.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Pressure gages
   1. Purpose
   2. Gage pressure (psig)
   3. Absolute pressure (psia)
   4. Spring loaded gages
   5. Bourdon tube types
   6. Bellow gage
   7. Plunger gage
b. Temperature gages
   1. Bimetallic gages
   2. Coefficient of expansion
   3. Thermostats
   4. Recording thermometer
c. Rotary pressure joints
d. Sight-flow indicator
e. Vacuum breakers
f. Accumulators

(Continued on back)

Provide Demonstration On:

Proper use of pipefitter's wrenches

Provide Practical Application On:

Monitoring gages and other accessories to maintain a pipeline. Repairing the line if necessary.

## INSTRUCTIONAL MATERIALS

Textbooks:

Audel, Plumber's and Pipefitter's Library

Student Manuals:

Plant Engineering Training Systems, Piping Systems, Lesson Ten

Tools and Equipment:

Pipefitter's wrenches

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 2 |

**EVALUATION** (IPM-86)

Given a pipeline with gages and other accessories, the student will monitor the flow and pressure for proper operation and repair the system as necessary. The student will use the appropriate pipefitter's wrench in the correct manner. The completed task must be in compliance with the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

g. Receivers
h. Actuators and intensifiers
    1. Linear actuators
    2. Single-or double-acting
    3. Intensifier
i. Pneumatic pressure line accessories
    1. Filter regulator
    2. Lubricator
    3. Air-line lubricator
j. Heat exchangers
k. Wrenches
    1. Monkey wrench
    2. Strap wrench
    3. Pipe wrench
    4. Pipe tongs
    5. Open-end wrenches
    6. Proper use of wrenches
l. Maintenance
    1. Preventive maintenance
    2. Repair maintenance

## TASK

IPM-87 Identifying principles of hydraulics

## PERFORMANCE OBJECTIVE

Identify principles of hydraulics.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Fluid power systems
    - 1. Pneumatics
    - 2. Hydraulics
- b. Force
- c. Weight
- d. Mass
- e. Pressure
    - 1. Atmospheric
    - 2. Hydraulic
- f. Work
- g. Power
- h. Types of energy used in hydraulic systems
    - 1. Electrical
    - 2. Hydraulic
    - 3. Kinetic
    - 4. Potential energy
    - 5. Heat energy
- i. Incompressible liquids
- j. Non-diffusion
- k. Hydrostatic pressure
- l. Pascal's Law
- m. Transmission of fluid power
- n. Fluid flow in pipes
    - 1. Stream line
    - 2. Turbulent
    - 3. Cavitation
- o. Bernoulli's Principle
- p. The effect of heat on liquids
- q. Hydraulic power system
    - 1. Pump
    - 2. Control valve
    - 3. Activating unit
    - 4. Hydraulic fluid
    - 5. Piping or tubing
- r. Modified base hydraulic system

## INSTRUCTIONAL MATERIALS

Textbooks:

- a. Pease, Basic Fluid Power
- b. Howard W. Sams and Co., ABC's of Hydraulic Circuits
- c. Pippenger and Hicks, Industrial Hydraulics
- d. Delmar, Electromechanical Technology Series, Fluids

Student Manuals:

Plant Engineering Training Systems, Basic Hydraulics, Lesson One

A/Vs:

Howard W. Sams and Co., "Fluid Power," transparency

**LAB HOURS** 1

**CLASS HOURS** 4

## EVALUATION (IPM-87)

Given an overview of basic hydraulics principles and terms, the student will identify the principles and describe the components of a basic hydraulic system. The completed task must be rated as acceptable according to the instructor's specifications.

## TASK

IPM-88 Identifying hydraulic fluids

## PERFORMANCE OBJECTIVE

Identify hydraulic fluids.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Functions of hydraulic fluids
b. Physical properties of hydraulic fluids
c. Viscosity
    1. Saybolt Universal Seconds (SUS)
    2. American Society for Testing Materials (ASTM)
    3. Viscosity and pressure
d. Pour point
e. Fluid selection
f. Effects of too low-too high fluid levels
g. Component protection
h. Chemical properties
i. System contamination

(Continued on back)

Provide Practical Application On:

Identifying types of hydraulic fluids

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics
c. Delmar, Electromechanical Technology Series, Fluids

Student Manuals:

Plant Engineering Training Systems, Basic Hydraulics, Lesson Two

Tools and Equipment:

Examples of types of hydraulic fluid

| | |
|---|---|
| LAB HOURS | 1 |
| CLASS HOURS | 4 |

## EVALUATION (IPM-88)

Given a hydraulic fluid, the student will describe the fluid in terms of viscosity, chemical properties and fluid type. The completed task must be rated as acceptable according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    1. Water - demulsification, vapor pressure
    2. Dissolved air
    3. Foaming
    4. Corrosion and rusting
j. Hydraulic fluid types
    1. Petroleum oils
    2. Oil-in-water emulsions
    3. Water-in-oil emulsions
    4. Water base glycols
    5. Chlorinated hyrdocarbons
    6. Phosphate esters
    7. Silicones
    8. Silicate esters

## TASK

IPM-89 Identifying strainers and filters in hydraulic systems

## PERFORMANCE OBJECTIVE

Identify strainers and filters in a hydraulic system.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Hydraulic system requirements
b. Removing contaminates
c. Degree of filtration
    1. Nominal
    2. Absolute
    3. Particle
d. Performance characteristics
e. Performance of different mediums
    1. Surface mediums
    2. Depth types
f. Strainers
    1. Mesh
    2. Primary use
    3. Reservoir strainers
    4. In line strainers
g. Filters

(Continued on back)

Provide Practical Application On:

Identifying several types of filters and strainers

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics
c. Delmar, Electromechanical Technology Series, Fluids

Student Manuals:

Plant Engineering Training Systems, Basic Hydraulics, Lesson Three

Tools and Equipment:

Several types of filters and strainers

| | |
|---|---|
| LAB HOURS | 1 |
| CLASS HOURS | 4 |

## EVALUATION (IPM-89)

Given a selection of filters and strainers, the student will identify and describe each type and its function. The completed task must meet the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

h. Fiber mediums
i. Magnetic mediums
j. Filter and strainer installations

## TASK

IPM-90 Identifying reservoirs and accumulators in a hydraulic system

## PERFORMANCE OBJECTIVE

Identify reservoirs and accumulators in a hydraulic system.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. System demands
   1. Function of a reservoir
   2. Function of an accumulator
b. Fluid reservoir requirements
   1. Storing a supply of hydraulic fluid
   2. Breaking up foam
   3. Settling heavy dirt, sludge and water
   4. Cooling the fluid
   5. Mounting platform for pump and other equipment
c. Baffles
d. Air separation
e. Reservoir cooling
f. Liquid heat exchanger
g. Reservoir accessories
   1. Pump intake strainers
   2. Suction gage
   3. Air breather
   4. Fluid level gage
   5. Thermometer
   6. The reservoir as support base for the power unit
h. Accumulators
   1. Stores fluid under pressure until needed by system
   2. Absorbs hydraulic shocks
i. Types of accumulators
   1. Weight loaded or gravity
   2. Spring-loaded piston
   3. Air bottle or non-separated gas
   4. Bladder or bag
   5. Diaphragm
   6. Gas charged piston
   7. Differential piston

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics
c. Delmar, Electromechanical Technology Series, Fluids

Student Manuals:

a. Plant Engineering Training Systems, Basic Hydraulics, Lesson Four
b. Oregon, Reservoirs

Tools and Equipment:

Hydraulic system (or diagram)

| | |
|---|---|
| LAB HOURS | 1 |
| CLASS HOURS | 4 |

## EVALUATION (IPM-90)

Given a hydraulic system, the student will identify reservoirs and accumulators and describe their purposes. The completed task must be rated as acceptable according to the instructor's specifications.

## TASK

IPM-91 Identifying hydraulic pumps on a system

## PERFORMANCE OBJECTIVE

Identify pumps on a hydraulic system.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Purpose of hydraulic pumps
b. Pump classifications
  1. Positive displacement
  2. Non-positive displacement
  3. Fixed or variable displacement
  4. Rotary
  5. Piston
  6. Radial piston
c. Rating selection factors
  1. Capacity
  2. Pressure
  3. Drive speed
  4. Efficiency
  5. Reliability
  6. Fluid characteristics
  7. Size and weight

(Continued on back)

Provide Practical Application On:

Identifying types of pumps from live examples, illustrations or diagrams

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics
c. Delmar, Electromechanical Technology Series, Fluids

Student Manuals

a. Plant Engineering Training Systems, Basic Hydraulics, Lesson Five
b. Oregon, Pumps

Tools and Equipment:

Pumps (live examples, illustrations or diagrams)

**LAB HOURS** 1

**CLASS HOURS** 4

## EVALUATION (IPM-91)

Given diagrams of pumps, the student will accurately identify the type of pump and describe its use.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

8. Control adaptability
9. Life
10. Installation and maintenance

d. Gear pumps
    1. External
    2. Internal
    3. Axial flow or screw
    4. Cycloidal

e. Vane pumps

f. Piston pumps
    1. Dexial piston
    2. Radial pistons
    3. Inlet and outlet check valve

## TASK

IPM-92 Identifying piping, tubing and fittings

## PERFORMANCE OBJECTIVE

Identify piping, tubing and fittings.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Hydraulic piping
b. Flow and velocity
    1. Laminar flow
    2. Velocity = $\frac{\text{flow (gpm)} \times 0.321}{\text{pipe area (sq. in.)}}$
c. Hydraulic pressure
d. Pressure loss
e. Pipe fittings
f. Threaded pipe
g. Installing pipe
h. Tubing
    1. Tube bending
    2. Tube fittings
i. Hoses

Provide Practical Application On:

Choosing the correct size pipe, fitting, coupling or hose for a job

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics
c. Delmar, Electromechanical Technology Series, Fluids

Student Manuals:

Plant Engineering Training Systems, Basic Hydraulics, Lesson Six

Tools and Equipment:

a. Pipe
b. Tube
c. Fittings
d. Hoses
e. Tools for pipe fitting

| | |
|---|---|
| LAB HOURS | 1 |
| CLASS HOURS | 4 |

## EVALUATION (IPM-92)

Given specifications for a job, the student will select the correct size pipe, fitting, coupling or hose and prepare the job for installation. The completed task must be in accordance with the instructor's specifications.

## TASK

IPM-93 Identifying directional control valves

## PERFORMANCE OBJECTIVE

Identify directional control valves.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Purpose of directional control valves
b. Manually operated valves
    1. Globe
    2. Plug
    3. Ball
    4. Needle
c. Automatic two-way valves
    1. Direct-acting
    2. Normally closed
    3. Pilot operated
d. Check valves
e. Spool valves
f. Fluid motor control
g. Normally open and normally closed three-way valves
h. Holding valves
i. Four-way valves

(Continued on back)

Provide Practical Application On:

Identifying types of directional control valves on a diagram of a hydraulic system

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics
c. Delmar, Electromechanical Technology Series, Fluids

Student Manuals:

a. Plant Engineering Training Systems, Basic Hydraulics, Lesson Seven
b. Oregon, Directional Control Valve

Tools and Equipment:

Diagram of a hydraulic system

| | |
|---|---|
| LAB HOURS | 1 |
| CLASS HOURS | 4 |

## EVALUATION (IPM-93)

Given a diagram of a hydraulic system, the student will accurately identify the types of directional control valves on the system using the diagram.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

j. Five-way valves
k. Rotary valves
l. Valve actuators
m. Special valves and accessories

## TASK

IPM-94 Identifying pressure control valves

## PERFORMANCE OBJECTIVE

Identify pressure control valves.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Pressure control valves
   1. Purpose
   2. Flow control
   3. Holding or sequence valve
b. Pressure relief valve
   1. Poppet or spool type
   2. Flow capacity
   3. Operating differential pressure
c. Spool valves
   1. Simple and direct acting spool valve
   2. Two-stage or compound
   3. Remote control
d. Sequence valves
e. Counter balance valves
f. Holding valves

(Continued on back)

Provide Practical Application On:

Identifying and describing types of pressure control valves from illustrations or live examples

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics
c. Delmar, Electromechanical Technology Series, Fluids

Student Manuals:

a. Plant Engineering Training Systems, Basic Hydraulics, Lesson Eight
b. Oregon, Pressure Relief Valves

LAB HOURS 1

CLASS HOURS 2

## EVALUATION (IPM-94)

Given illustrations or live examples of pressure control valves, the student will correctly identify the type of valve and describe its purpose.

### INSTRUCTIONAL ACTIVITIES

Provide Information On:

g. Unloading valves
h. Pressure reducing valves
i. Shock suppressors
j. Flow control valves
k. Pressure compensation
l. Temperature compensation

## TASK

IPM-95 Identifying cylinders in a hydraulic system

## PERFORMANCE OBJECTIVE

Identify cylinders used in a hydraulic system.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Purpose of cylinders
b. Double-acting cylinders
c. Single-acting cylinders
    1. Ram
    2. Telescoping cylinders
d. Two-piston cylinders
e. Positional cylinders
f. Cylinder construction
    1. Piston rings and seals
    2. Road packing
g. Cylinder mounting
    1. Fixed
    2. Pivoted
    3. Centerline
    4. Non-centerline
h. Selecting a cylinder
i. Flow capacity

(Continued on back)

Provide Practical Application On:

Selecting the appropriate cylinder for a hydraulic system

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics
c. Morrow, Maintenance Engineering Handbook
d. Delmar, Electromechanical Technology Series, Fluids

Student Manuals:

a. Plant Engineering Training Systems, Basic Hydraulics, Lesson Nine
b. Oregon, Cyclinders

Tools and Equipment:

Cylinders

| | |
|---|---|
| LAB HOURS | 1 |
| CLASS HOURS | 4 |

## EVALUATION (IPM-95)

Given specifications of a system which requires a cylinder, the student will select an appropriate cylinder for the system. The selection will be rated according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

j. Cushioning
k. Piston rod strength

## TASK

IPM- 96 Identifying hydraulic motors

## PERFORMANCE OBJECTIVE

Identify hydraulic motors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Purpose of hydraulic motors
b. Classification of motors
    1. Positive displacement
    2. Fixed displacement
    3. Variable displacement
c. Rating and selection factors
    1. Pressure range
    2. Speed range
    3. Torque
    4. Horsepower
    5. Overall efficiency
    6. Volumetric efficiency
    7. Size, weight and mounting requirements of motor
    8. Reliability and service life
d. Hydraulic motor construction

(Continued on back)

Provide Practical Application On:

Selecting an appropriate motor for a system

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics
c. Morrow, Maintenance Engineering Handbook
d. Delmar, Electromechanical Technology Series, Fluids

Student Manuals:

Plant Engineering Training Systems, Basic Hydraulics, Lesson Ten

Tools and Equipment:

Hydraulic motors

| | |
|---|---|
| LAB HOURS | 3 |
| CLASS HOURS | 4 |

## EVALUATION (IPM-96)

Given specifications for a system and considering all rating factors, the student will select an appropriate motor. The selection will be rated by the instructor according to industry specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

e. Gear motors
    1. External
    2. Internal
    3. Non-separated
f. Vane motors
g. Piston motors
h. Rotary actuators

## TASK

IPM-97 Troubleshooting hydraulic systems using schematics

## PERFORMANCE OBJECTIVE

Troubleshoot a hydraulic system.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Components of a hydraulic system
   1. Pump and drive units
   2. Actuators
   3. Control valves
   4. Conductors and connectors
   5. Hydraulic fluid
   6. Fluid storage and conditioning equipment
b. Tracing the system
   1. Getting to know the system
   2. Circuit and system diagrams
c. Mechanical set-up
d. Understanding components
e. System operation

Provide Practical Application On:

Using a schematic to troubleshoot a hydraulic system for a particular problem

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippinger and Hicks, Industrial Hydraulics

Student Manuals:

Plant Engineering Training Systems, Hydraulic Troubleshooting, Lesson One

Tools and Equipment:

Schematics of a hydraulic system

| | |
|---|---|
| LAB HOURS | 6 |
| CLASS HOURS | 4 |

## EVALUATION (IPM-97)

Given a schematic of a hydraulic system, the student will trace the system to troubleshoot a given problem. The completed task must be in compliance with the instructor's specifications.

## TASK

IPM-98 Reading hydraulic schematic diagrams

## PERFORMANCE OBJECTIVE

Read a hydraulic schematic diagram.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types of hydraulic diagrams
b. What is a schematic?
c. Characteristics of schematics
d. Guidelines for reading schematics
    1. Looking for flow pattern
    2. Looking for guides
    3. Reading carefully
    4. Using a step-by-step approach
e. Basic elements of a hydraulic system
    1. Pumps
    2. Control valves
    3. Conductors and connectors

(Continued on back)

Provide Practical Application On:

Reading and interpreting a schematic of a hydraulic system

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics

Student Manuals:

Plant Engineering Training Systems, Hydraulic Trouble-Shooting, Lesson Two

LAB HOURS 6
CLASS HOURS 4

**EVALUATION** (IPM-98)

Given a schematic diagram of a hydraulic system, the student will interpret the system according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

4. Fluid storage and conditioning equipment
5. A hydraulic circuit

f. Sequence valve circuit

## TASK

IPM-99 Installing hydraulic components

## PERFORMANCE OBJECTIVE

Install hydraulic components.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Installation considerations
   1. Cleanliness
   2. Installation safety
b. Pump and drive installations
   1. Rigid mounting
   2. Styles of pumps
c. Pump start-up
   1. Checking the pump
   2. Cleanliness
   3. Proper direction of rotation
   4. Correct fluid
   5. Start pump
   6. Purge air after five minutes

(Continued on back)

Provide Practical Application On:

Installing a pump and a control valve on a hydraulic system

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics

Student Manuals:

Plant Engineering Training Systems, Hydraulic Troubleshooting, Lesson Three

Tools and Equipment:

a. Pump
b. Control valve
c. Tools
d. Schematic

| | |
|---|---|
| LAB HOURS | 6 |
| CLASS HOURS | 4 |

## EVALUATION (IPM-99)

Given appropriate tools and equipment, the student will properly install a pump and control valve on a hydraulic system. The installation must meet the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

d. Final pump start-up check
    1. Check joints for leakage
    2. Fluid level in reservoir
    3. Fluid temperatures
    4. System pressure
    5. Spongy operation
e. Control valve installation
    1. Sub-plate connections
    2. In line threaded connections
    3. In line flanged connections
    4. Manifold
f. Extra valve ports for convenience
g. Valve port identification
h. Mechanical valve installation
i. Pneumatically actuated valves
j. Electrically controlled valves

## TASK

IPM-100 Installing pipes and tubes

## PERFORMANCE OBJECTIVE

Install pipes, tubes and hoses.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Conductors and connectors
   1. Pipes
   2. Tubes
   3. Hoses
b. Hydraulic pipe
c. General installation procedures
   1. Never overtighting tapered connections
   2. Never welding a fitting attached to a component
   3. Always using full size pipe or fittings for a coupling
   4. Never turning fittings on pipe to put tension or compression on the

(Continued on back)

Provide Practical Application On:

Installing pipes, tubes or hoses on a hydraulic system

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics

Student Manuals:

Plant Engineering Training Systems, Hydraulic Troubleshooting, Lesson Four

Tools and Equipment:

a. Pipes
b. Tubes
c. Fittings and couplings
d. Tools

**LAB HOURS** 4

**CLASS HOURS** 4

## EVALUATION (IPM-100)

Given an assignment to install pipes, tubes or hoses on a hydraulic system, the student will follow correct procedure for the installation. The procedure must be rated acceptable according to the instructor's specifications.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

connector
    5. Providing support for the components
    6. Counting tools when installation is finished
d. Hydraulic tubing
    1. Cutting the tube
    2. Deburring
    3. Tube flaring
    4. Tube bending
    5. Assembling the tube
e. Hydraulic hose
f. Seal installation
g. Reservoir installation
h. Filter installation
i. Cooler and heat exchange installation
j. Actuator installation

## TASK

IPM-101 Selecting hydraulic fluids

## PERFORMANCE OBJECTIVE

Select hydraulic fluids.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Hydraulic fluid selection criteria
   1. Lubricating properties
   2. Viscosity and viscosity index
   3. Resistance to chemical and physical changes
   4. Low temperature properties
   5. Demulsibility
   6. Anti-rust properties
   7. Fire-resistance
   8. Compatibility
   9. General properties

b. Selection of fluid

c. Filling the system

d. Filter installation

Provide Demonstration On:

Filling a system with fluid

Provide Practical Application On:

Selecting hydraulic fluid, filling the system and installing a new filter

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power

b. Pippenger and Hicks, Industrial Hydraulics

c. Morrow, Maintenance Engineering Handbook

Student Manuals:

Plant Engineering Training Systems, Hydraulic Troubleshooting, Lesson Five

Tools and Equipment:

a. Hydraulic fluid

b. Filter

c. Tools

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 4 |

## EVALUATION (IPM-101)

Given a hydraulic system, the student will select the appropriate fluid, fill the system to the correct level and change the filter. All completed tasks must comply with the instructor's specifications.

## TASK

IPM-102 Planning system maintenance

## PERFORMANCE OBJECTIVE

Plan system maintenance.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Classifying maintenance
   1. Service
   2. Inspection
   3. Repair
   4. Reconditioning
   5. Testing
b. Inspection
c. Organize the maintenance
   1. Identifying each system
   2. Keeping a file for maintenance records
d. Maintenance requirements
e. Regular inspections
f. Reservoir fluid level
g. Reservoir fluid temperature
h. External leaks
i. External condition of system

(Continued on back)

Provide Practical Application On:

Developing a maintenance plan for a hydraulic system

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics

Student Manuals:

Plant Engineering Training Systems, Hydraulic Troubleshooting, Lesson Six

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 3 |

**EVALUATION** (IPM-102)

Given a hydraulic system, the student will plan a maintenance schedule which includes inspection, servicing and overhauling. The system must meet the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

j. Operating pressure
k. Fluid quality
l. Filters
m. Machine performance
n. Repair planning
o. Reconditioning planning
p. System servicing

## TASK

IPM-103 Troubleshooting hydraulic systems (diagnostic techniques)

## PERFORMANCE OBJECTIVE

Troubleshoot a hydraulic system.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. What is troubleshooting?
    1. Diagnosis and symptoms
    2. Evaluating maintenance history
    3. Evaluating symptoms
    4. Determining the cause
    5. Identifying the solution
b. Tools and gages
    1. Wrenches
    2. Gages
c. Applying troubleshooting procedures

Provide Practical Application On:

Troubleshooting a hydraulic system

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics

Student Manuals:

Plant Engineering Training Systems, Hydraulic Troubleshooting, Lesson Seven

Tools and Equipment:

a. Tools
b. Gages
c. Mainenance history records

| | |
|---|---|
| LAB HOURS | 6 |
| CLASS HOURS | 4 |

## EVALUATION (IPM-103)

Given a defective hydraulic system and appropriate tools, gages and maintenance records, the student will troubleshoot the system and correctly diagnose the problem according to the instructor's specifications.

## TASK

IPM-104 Troubleshooting valves

## PERFORMANCE OBJECTIVE

Troubleshoot valves.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Valve problems
    1. Excessive leakage
    2. Sticking or jamming
    3. Bad controller element
    4. Cracked or broken parts
    5. Distorted or broken springs
b. Valve test procedures
c. Repair procedures
    1. Disassembly
    2. Cleaning
    3. Inspection
    4. Repairing or replacing
    5. Reassembly
    6. Setting to specifications
    7. Testing

(Continued on back)

Provide Practical Application On:

Troubleshooting and repairing a faulty valve

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics

Student Manuals:

Plant Engineering Training Systems, Hydraulic Troubleshooting, Lesson Eight

Tools and Equipment:

a. Valves
b. Tools
c. Parts
d. Gages

| | |
|---|---|
| LAB HOURS | 3 |
| CLASS HOURS | 2 |

**EVALUATION** (IPM-104)

Given a valve with a defect and appropriate tools, gages and parts, the student will troubleshoot and repair the valve according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

d. Solenoid problems
    1. Melted insulation
    2. Physical destruction

## TASK

IPM-105 Troubleshooting cylinders

## PERFORMANCE OBJECTIVE

Troubleshoot cylinders.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Description of cylinders
b. Troubleshooting a cylinder
c. Cylinder testing
d. Cylinder repair
e. Shock absorbers
f. Safety

Provide Practical Application On:

Troubleshooting and repairing a cylinder

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics

Student Manuals:

Plant Engineering Training Systems, Hydraulic Troubleshooting, Lesson Nine

Tools and Equipment:

a. Cylinders
b. Tools and gages

| | |
|---|---|
| LAB HOURS | 6 |
| CLASS HOURS | 4 |

## EVALUATION (IPM-105)

Given a defective cylinder and appropriate tools and gages, the student will troubleshoot the cylinder, repair the problem and re-install the cylinder according to the instructor's specifications.

## TASK

IPM-106 Troubleshooting pumps and motors

## PERFORMANCE OBJECTIVE

Troubleshoot pumps and motors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Pumps and motors
  1. Gear
  2. Vane
  3. Axial
  4. Radial
b. Troubleshooting test for
  1. Pressure
  2. Flow
  3. Temperature
c. Gear pump problems
  1. Contamination
  2. Proper fluid conditions
  3. Cavitation
  4. Bearing and shaft wear
d. Vane pump problems
e. Vane motors
f. Axial piston pump problems

(Continued on back)

Provide Practical Application On:

Troubleshooting a hydraulic system for a pump or motor problem and repairing the defective parts

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics

Student Manuals:

Plant Engineering Training Systems, Hydraulic Troubleshooting, Lesson Ten

Tools and Equipment:

a. Hydraulic system with a defective pump or motor
b. Tools and gages

**LAB HOURS** 8
**CLASS HOURS** 2

## EVALUATION (IPM-106)

Given a hydraulic system with a defective pump or motor and appropriate tools and gages, the student will troubleshoot and repair the defective component according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

g. Radial piston pump problems
h. Pump and motor repair
i. Pump maintenance checks

## TASK

IPM-107 Identifying pneumatic principles

## PERFORMANCE OBJECTIVE

Identify basic principles of pneumatics.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Pneumatic power systems
  - 1. Pneumatic tools
  - 2. Linear motion devices
  - 3. Door openers
  - 4. Rotary motion devices
- b. Force, weight and mass
- c. Pressure
  - 1. Atmospheric
  - 2. Below atmospheric
  - 3. Pneumatic system pressure
- d. Work and energy
- e. Power
- f. Energy used in pneumatic systems
  - 1. Electrical
  - 2. Pneumatic
  - 3. Kinetic
  - 4. Potential
  - 5. Heat
- g. Diffusion and dispersion
- h. Separation of gases and liquids
- i. Compressibility
- j. Pneumatic laws
  - 1. Pascal's Law
  - 2. Boyle's Law
  - 3. Charles Law
  - 4. Ideal Gas Law
- k. Transmission of pneumatic fluid power
- l. Pneumatic leverage
- m. Air properties
- n. Air flow in pipes
- o. Viscosity of air
- p. Bernoulli's Principle
- q. Pneumatic power systems

## INSTRUCTIONAL MATERIALS

Textbooks:

- a. Pease, Basic Fluid Power
- b. Stewart and Storer, Fluid Power

A/Vs:

Bobbs-Merrill, "Fluid Power," transparency

Student Manuals:

- a. Plant Engineering Training Systems, Basic Pneumatics, Lesson One
- b. Bobbs-Merrill, Fluid Power

| | |
|---|---|
| LAB HOURS | 1 |
| CLASS HOURS | 4 |

## **EVALUATION** (IPM-107)

Given an overview of basic pneumatic power system principles, the student will correctly identify basic pneumatic principles and terminology.

## TASK

IPM-108 Identifying reciprocating compressors

## PERFORMANCE OBJECTIVE

Identify and describe reciprocating compressors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Compressor operation
b. Compressor classification
    1. Positive displacement
    2. Dynamic
c. Reciprocating piston
d. Single and double-acting compressors
e. Compressor construction
f. Horsepower cooling requirements
    1. Intercooling
    2. Aftercooler
    3. Water-cooled
    4. Counter-flow
    5. Parallel flow
g. Compressor lubrication
    1. Reducing friction

(Continued on back)

Provide Practical Application On:

Identifying types of reciprocating compressors in the lab or in a plant

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

A/Vs:

Bobbs-Merrill, "Fluid Power," transparency

Student Manuals:

a. Plant Engineering Training Systems, Basic Pneumatics, Lesson Two
b. Bobbs-Merrill, Fluid Power

Tools and Equipment:

Several types of reciprocating compressors

| | |
|---|---|
| LAB HOURS | 1 |
| CLASS HOURS | 4 |

## EVALUATION (IPM-108)

Given a reciprocating compressor, the student will accurately identify the type of compressor and describe it in terms of controls, lubrication requirements and application.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    2. Improve transfer of heat
    3. Splash or pressurized
h. Non-lubricated compressors
i. Compressor controls
    1. Unloading
    2. Holding type
    3. Suction unloader valves
    4. Centrifugal pressure release
    5. Electric or magnetic unloader

## TASK

IPM-109 Identifying rotary compressors

## PERFORMANCE OBJECTIVE

Identify rotary compressors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Compressor classification
b. Compressor selection
c. Compressor accessories

Provide Practical Application On:

Identifying rotary compressor

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

A/Vs:

Bobbs-Merrill, "Fluid Power," transparency

Student Manuals:

a. Plant Engineering Training Systems, Basic Pneumatics, Lesson Three
b. Bobbs-Merrill, Fluid Power

Tools and Equipment:

Selection of several rotary compressors

**LAB HOURS** 1

**CLASS HOURS** 4

**EVALUATION** (IPM-109)

Given a rotary compressor, the student will accurately classify the compressor and describe its operation and application.

## TASK

IPM-110 Identifying primary air treatment in pneumatic systems

## PERFORMANCE OBJECTIVE

Identify primary air treatment in a pneumatic system.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Air treatment
b. Preliminary filtering
    1. Dry or wet filters
    2. Cleaning a filter
c. Relative humidity
    1. Temperature
    2. Weather
    3. Air pressure
d. Effects of moisture
e. Water removal
    1. Condensers after coolers
    2. Water and air cooled
f. Dew point
g. Moisture separators
    1. Gravity separation
    2. Drain plugs - safety
h. Oil scrubbers

(Continued on back)

Provide Practical Application On:

Identifying methods of air treatment and in a pneumatic system

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

A/Vs:

Bobbs-Merrill, "Fluid Power," transparency

Student Manuals:

a. Plant Engineering Training Systems, Basic Pneumatics, Lesson Four
b. Bobbs-Merrill, Fluid Power

**LAB HOURS** 1

**CLASS HOURS** 4

**EVALUATION** (IPM-110)

Given a pneumatic system, the student will accurately identify and describe air treatment methods.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    1. Operation
    2. Maintenance
i. Air dryers
    1. Delinquescent
    2. Adsorption
j. Air receivers

## TASK

IPM-111 Identifying secondary air treatment methods

## PERFORMANCE OBJECTIVE

Identify methods of secondary air treatment.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Methods of treatment
b. Contaminant separation
c. Contaminant filtration
d. Filter classification and rating
e. Types of medium surface filters
f. Depth filters
g. Absorption filters
h. Lubricating

Provide Practical Application On:

Identifying secondary air treatment methods used on a pneumatic system

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, *Basic Fluid Power*
b. Stewart and Storer, *Fluid Power*

A/Vs:

Bobbs-Merrill, "Fluid Power," transparency

Student Manuals:

a. Plant Engineering Training Systems, *Basic Pneumatics*, *Lesson Five*
b. Bobbs-Merrill, *Fluid Power*

Tools and Equipment:

Diagram or live pneumatic system

| | |
|---|---|
| LAB HOURS | 1 |
| CLASS HOURS | 4 |

**EVALUATION** (IPM-111)

Given a pneumatic system, the student will accurately identify and describe secondary air treatment methods.

## TASK

IPM-112 Identifying piping, hoses and fittings used in pneumatic systems

## PERFORMANCE OBJECTIVE

Identify the types of piping, hoses and fittings used in a pneumatic system.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Piping requirements
    1. Pipe, tubing, hose and fitting combinations
    2. Free of leaks
b. Air flow
    1. Streamlined
    2. Lominar flow
    3. Selection of pipe size
c. Piping
    1. Black steel pipe
    2. Bursting pressure
    3. Safety factor
    4. Threading, welding and flonging
d. Pipe applications
e. Metallic tubing
f. Tube bending

(Continued on back)

Provide Practical Application On:

Installing pipes, tubes or hoses on a pneumatic system

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

A/Vs:

Bobbs-Merrill, "Fluid Power," transparency

Student Manuals:

a. Plant Engineering Training Systems, Basic Pneumatics, Lesson Six
b. Bobbs-Merrill, Fluid Power

Tools and Equipment:

a. Pipe
b. Tube
c. Hose
d. Fittings and couplings
e. Tools

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (IPM-112)

Given appropriate tools, supplies and equipment, the student will accurately use the correct procedure to install pipe, hoses and tubing on a pnuematic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

g. Tube fittings
h. Installation of tube
i. Non-metallic tubing
j. Hoses and fittings
k. Hose installation

## TASK

IPM-113 Identifying control valves

## PERFORMANCE OBJECTIVE

Identify control valves.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Control valves
b. Manually operated valves
c. Automatically operated valves
d. Check valves
    1. Flapper
    2. Poppet
    3. Ball
    4. Cracking pressure
e. Self-activated shuttle valves
f. Control valves
    1. Spool
    2. Poppet
    3. Reciprocating disc
    4. Rotary
g. Three-way valves
h. Four-way valves

(Continued on back)

Provide Practical Application On:

Identifying types of valves from diagrams or live examples

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

A/Vs:

Bobbs-Merrill, "Fluid Power," transparency

Student Manuals:

a. Plant Engineering Training Systems, Basic Pneumatics, Lesson Seven
b. Bobbs-Merrill, Fluid Power

Tools and Equipment:

Valves or diagrams of different types of valves

**LAB HOURS** 1
**CLASS HOURS** 4

## EVALUATION (IPM-113)

Given a control valve or diagram, the student will correctly identify the valve and describe its purpose.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

i. Five-way valves
j. Valve accessories

## TASK

IPM-114 Identifying pressure relief valves

## PERFORMANCE OBJECTIVE

Identify pressure relief valves.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Controlling pressure
b. Safety valves
c. Relief valves
d. Refill valve construction
e. Pressure regulators
f. Regulator modifications
g. Safety

Provide Demonstration On:

Setting or adjusting a regulator

Provide Practical Application On:

Identifying, setting or adjusting a regulator

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

A/Vs:

Bobbs-Merrill, "Fluid Power," transparency

Student Manuals:

a. Plant Engineering Training Systems, Basic Pneumatics, Lesson Eight
b. Bobbs-Merrill, Fluid Power

| | |
|---|---|
| LAB HOURS | 1 |
| CLASS HOURS | 4 |

## EVALUATION (IPM-114)

Given a pneumatic system with a pressure regulator, the student will correctly identify, set or adjust the valve according to the appropriate specifications.

## TASK

IPM-115 Identifying cylinders

## PERFORMANCE OBJECTIVE

Identify cylinders.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Pneumatic cylinders
b. Double-acting cylinders
c. Single-acting cylinders
d. Two-piston cylinders
e. Rod packings
f. Mounting
g. Selecting a cylinder
h. Cushioning
i. Piston rod strength

Provide Practical Application On:

Selecting a cylinder for a pneumatic system

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

A/Vs:

Bobbs-Merrill, "Fluid Power," transparency

Student Manuals:

a. Plant Engineering Training Systems, Basic Pneumatics, Lesson Nine
b. Bobbs-Merrill, Fluid Power

Tools and Equipment:

a. Cylinders and specifications
b. Pneumatic system

| | |
|---|---|
| LAB HOURS | 1 |
| CLASS HOURS | 2 |

## EVALUATION (IPM-115)

Given a pneumatic system and specifications, the student will correctly select the correct capacity cylinder for use with the system.

## TASK

IPM-116 Identifying motors

## PERFORMANCE OBJECTIVE

Identify motors.

## INSTRUCTIONAL ACTIVITIES

**Provide Information On:**

a. Pneumatic motors
b. Motor classification
    1. Piston motors
    2. Vane motors
    3. Positive diaplacement
c. Rating and selection factors
    1. Pressure rating
    2. Speed range
    3. Torque
    4. Horsepower
    5. Size, weight and mounting
d. Motor construction
e. Piston motors
f. Rotary activators
g. Portable air tools
l. Air boosters

**Provide Practical Application On:**

Selecting a motor and installing it on a pneumatic system

## INSTRUCTIONAL MATERIALS

**Textbooks:**

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

**A/Vs:**

Bobbs-Merrill, "Fluid Power," transparency

**Student Manuals:**

a. Plant Engineering Training Systems, Basic Pneumatics, Lesson Ten
b. Bobbs-Merrill, Fluid Power

**Tools and Equipment:**

a. Motors
b. Pneumatic system
c. Tools

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 2 |

## **EVALUATION** (IPM-116)

Given a pneumatic system and specifications, the student will accurately select an appropriately rated motor and install the motor on the system.

253

## TASK

IPM-117 Identifying components of pneumatic systems

## PERFORMANCE OBJECTIVE

Identify the components of a pneumatic system.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. The pneumatic system
   1. Components
   2. Power
b. The air supply system
c. Reciprocating compressors
   1. Single-acting
   2. Double-acting
   3. Multi-stage
   4. Piston displacement
d. Regulation and control
   1. Unloading mechanisms
   2. Suction valve-unloading
   3. Clearance pocket unloading
   4. Throtteling the intake
e. Rotary compressors
   1. Sliding vane

(Continued on back)

Provide Practical Application On:

Identifying components of a pneumatic system

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

A/Vs:

Bobbs-Merrill, "Fluid Power," transparency

Student Manuals:

Plant Engineering Training Systems, Pneumatic Trouble-shooting, Lesson One

Tools and Equipment:

Diagram of a pneumatic system

| | |
|---|---|
| LAB HOURS | 1 |
| CLASS HOURS | 4 |

## EVALUATION (IPM-117)

Given a diagram of a pneumatic system, the student will accurately identify the components and describe their functions.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    2. Rotary screw
    3. Impeller
    4. Liquid ring
    5. Diaphragm
f. Cooling
    1. Intercooling
    2. After cooling
g. Compressor preventive maintenance
h. The delivered air system
    1. Filters/separators
    2. Absorption drying
i. Air line filters
j. Air line lubrication

## TASK

IPM-118 Reading pneumatic schematic diagrams

## PERFORMANCE OBJECTIVE

Read and interpret a pneumatic schematic diagram.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types of symbols
    1. Pictorial
    2. Cutaway
    3. Schematic
b. Constructing symbols
    1. Basic symbols
    2. Functional symbols
    3. Complete, simplified and composite
c. Diagramming an air supply system
    1. A simple system
    2. Timing circuits
    3. Safety circuits
d. Symbols for special devices
e. Reading a system schematic

Provide Demonstration On:

Finding the direction of flow on a pneumatic diagram

Provide Practical Application On:

Reading a pneumatic diagram and interpreting it

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

Student Manuals:

Plant Engineering Training Systems, Pneumatic Troubleshooting, Lesson Two

Tools and Equipment:

Pneumatic schematic diagrams

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|---|---|
| LAB HOURS | 1 |
| CLASS HOURS | 4 |

**EVALUATION** (IPM-118)

Given a schematic diagram of a pneumatic system, the student will accurately read the diagram and interpret all symbols including the direction of flow.

## TASK

IPM-119 Installing system components

## PERFORMANCE OBJECTIVE

Install components on a pneumatic system.

## INSTRUCTIONAL ACTIVITIES

**Provide Information On:**

a. Compressor and auxiliaries
    1. Air intake failures
    2. Location of compressor
    3. Installation requirements
b. Compressor intakes
    1. Location
    2. Mounting
    3. Filter
c. Compressor foundations
d. After coolers
e. Receivers
f. Dryers
g. Pipe installation
    1. Pipe support
    2. Pipe threads
    3. Tubing
    4. Tube fittings

(Continued on back)

**Provide Practical Application On:**

Installing a given component on a pneumatic system

## INSTRUCTIONAL MATERIALS

**Textbooks:**

a. Pease, *Basic Fluid Power*
b. Stewart and Storer, *Fluid Power*

**A/Vs:**

Bobbs-Merrill, "Fluid Power," transparency

**Student Manuals:**

Plant Engineering Training Systems, *Pneumatic Troubleshooting, Lesson Three*

**Tools and Equipment:**

a. Pneumatic components
b. Installation tools and supplies

LAB HOURS 1
CLASS HOURS 4

## EVALUATION (IPM-119)

Given a component of a pneumatic system, the student will accurately install the component on the pneumatic system. Correct procedures and observing all safety recommendations must be adhered to by the student.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    5. Hose installation
h. Control systems
    1. Control valve installation
    2. Solenoid coils
i. Cylinder installation
j. Safety

## TASK

IPM-120 Identifying procedures for pneumatic system maintenance

## PERFORMANCE OBJECTIVE

Identify procedures for maintenance of a pneumatic system.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Planning maintenance
   1. Lubrication
   2. Adjustment
   3. Preventive maintenance
b. Compressor room maintenance
   1. Compressor load
   2. Intake air filter
   3. Crankcase oil level
   4. Belts or belt driven units
c. System maintenance
   1. Drains and moisture traps
   2. Filters and separations
   3. Air pressure
   4. Lubricators
d. Control system maintenance

(Continued on back)

Provide Demonstration On:

Developing a maintenance log

Provide Practical Application On:

Developing a maintenance log

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

Student Manuals:

Plant Engineering Training Systems, Pneumatic Troubleshooting, Lesson Four

LAB HOURS 5

CLASS HOURS 5

**EVALUATION** (IPM-120)

Given a pneumatic system, the student will correctly identify procedures for maintaining the system and for setting up and keeping maintenance records.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    1. Shutting off the system for maintenance
    2. Regulators
    3. Cylinders
e. Tool maintenance
    1. Reasonable handling
    2. Lubrication
f. Keeping a maintenance log

261

## TASK

IPM-121 Determining system failures

## PERFORMANCE OBJECTIVE

Determine system failures.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Understanding the system
b. Troubleshooting procedure
c. Locating troubles
d. Using the operations manual
e. Checking the air supply
f. Troubleshooting the actuator
g. Checking the control valve
h. Checking a control valve actuator
i. Checking sequence valves
j. Checking master control valve
k. Checking interlocks
l. Making final adjustments and operating the system

Provide Practical Application On:

Troubleshooting a pneumatic system

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

Student Manuals:

Plant Engineering Training Systems, Pneumatic Troubleshooting, Lesson Five

Tools and Equipment:

a. Schematic of system
b. Operations manual

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

**EVALUATION** (IPM-121)

Given a defective pneumatic system, the student will accurately troubleshoot the system, correct the problem and operate the system to test for proper operation.

## TASK

IPM-122 Troubleshooting air compressors

## PERFORMANCE OBJECTIVE

Troubleshoot air compressors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Reciprocating compressor cooling
b. Compressor lubrication
c. Compressor valves
d. Crankcase ventilation
e. Piston rings and bearings
f. Control systems
g. Rotary compressors
h. Vane compressors
i. Rotary screw compressors
j. Centrifugal compressors

Provide Practical Application On:

Troubleshooting and repairing a faulty compressor

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

Student Manuals:

Plant Engineering Training Systems, Pneumatic Troubleshooting, Lesson Six

264

| | |
|---|---|
| LAB HOURS | 6 |
| CLASS HOURS | 4 |

**EVALUATION** (IPM-122)

Given a faulty air compressor, the student will accurately troubleshoot the compressor and repair it to normal operation.

## TASK

IPM-123 Troubleshooting control valves

## PERFORMANCE OBJECTIVE

Troubleshoot control valves.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Troubleshooting controls
   1. Non-starting
   2. Improper sequencing
   3. Miscellaneous equipment related problems
b. Troubleshooting a circuit that won't start
   1. Electric power
   2. Pneumatic power
   3. Manual overrides
   4. Sequence
   5. Lockouts
   6. Mechanical interference
   7. Solenoids
c. Checking manual overrides
d. Checking for lockouts
e. Checking circuit sequence
f. Checking for mechanical interference

(Continued on back)

Provide Practical Application On:

Troubleshooting and repairing a faulty control valve

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

Student Manuals:

Plant Engineering Training Systems, Pneumatic Troubleshooting, Lesson Seven

**LAB HOURS** 6

**CLASS HOURS** 4

## EVALUATION (IPM-123)

Given a pneumatic system with a faulty control valve, the student will troubleshoot the valve and correct the problem according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

g. Checking electrical solenoids
h. Troubleshooting improper sequence operation
i. Improper valve shifting
j. Changes in control timing
k. Miscellaneous problems
l. Lubrication problems

## TASK

IPM-124 Troubleshooting cylinders

## PERFORMANCE OBJECTIVE

Troubleshoot cylinders.

## INSTRUCTIONAL ACTIVITIES

**Provide Information On:**

a. Cylinders
   1. Purpose
   2. Construction
   3. Pistons
   4. Piston rings, "O" rings
b. Cylinder troubleshooting and repair
   1. Checking cylinder size
   2. Proper air pressure
   3. Misalignment
   4. Worn packings and seals
   5. General installation
   6. Speed controls

**Provide Practical Application On:**

Troubleshooting and repairing or replacing a faulty cylinder

## INSTRUCTIONAL MATERIALS

**Textbooks:**

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

**Student Manuals:**

Plant Engineering Training Systems, Pneumatic Troubleshooting, Lesson Eight

| | |
|---|---|
| LAB HOURS | 3 |
| CLASS HOURS | 2 |

## EVALUATION (IPM-124)

Given a pneumatic system with a faulty cylinder, the student will accurately troubleshoot and replace or repair the cylinder. The completed work must meet the instructor's specifications.

## TASK

IPM-125 Troubleshooting air motors

## PERFORMANCE OBJECTIVE

Troubleshoot air motors.

## INSTRUCTIONAL ACTIVITIES

### Provide Information On:

a. Uses of air motors
b. Checking for sufficient air
c. Contaminated air
d. Lubrication
e. Air motor abuse
f. Hose and clamp maintenance
g. Air motor troubleshooting
h. Vane motors
i. Radial piston motor
j. Axial piston air motors
k. Percussion tools
l. Safety

### Provide Practical Application On:

Troubleshooting a faulty air motor and repairing it

## INSTRUCTIONAL MATERIALS

### Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

### Student Manuals:

Plant Engineering Training Systems, Pneumatics Troubleshooting, Lesson Nine

| | |
|---|---|
| LAB HOURS | 6 |
| CLASS HOURS | 4 |

## EVALUATION (IPM-125)

Given a faulty air motor, the student will accurately troubleshoot and repair the motor according to the instructor's specifications.

## TASK

IPM-126 Troubleshooting pneumatic and hydraulic systems

## PERFORMANCE OBJECTIVE

Troubleshooting a pneumatic and hydraulic system.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Air oil tanks
b. Air hydraulic boosters
c. Pressure boosters
d. Single-pressure booster systems
e. Dual-pressure booster systems
f. Hydraulic control cylinders
g. Fast advance cylinders
h. Combined air oil cylinders
i. Pneumatic cushioning
j. Air hydraulic system interlock
k. Pneumatic service

Provide Practical Information On:

Troubleshooting and repairing a pneumatic/hydraulic system

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

Student Manuals:

Plant Engineering Training Systems, Pneumatic Troubleshooting, Lesson Ten

| | |
|---|---|
| LAB HOURS | 4 |
| CLASS HOURS | 2 |

## EVALUATION (IPM-126)

Given a defective system which is both pneumatically and hydraulically operated, the student will correctly identify the system, troubleshoot the problem and repair it according to the instructor's specifications.

## TASK

EL-01 Identifying basic electrical theory

## PERFORMANCE OBJECTIVE

Define the theory and nature of electricity.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. The atom
b. Lightening
c. Types of insulators
d. Types of conductors
e. Direct current
f. Alternating current
g. Defining volts
h. Defining watts
i. Defining amperes
j. Describing loads
k. Calculating loads
l. Defining electrical terms
m. Ohm's law
n. Types of connections
o. Types of splices
p. Making splices

Provide Demonstration On:

Making connections and splices

Provide Practical Application On:

a. Drawing two atoms, one positive, one negative
b. Working problems using Ohm's law
c. Working problems using power formula
d. Figuring voltage drop using Ohm's law and resistance formula
e. Making several types of connections and splices

## INSTRUCTIONAL MATERIALS

Textbooks:

a. AAVIM, Electrical Wiring
b. AAVIM, Understanding Electricity and Electrical Terms
c. Alerich, Electrical Construction Wiring

A/Vs:

Georgia, Electricity, "Understanding Basic Electrical Theory," slide/tape EL-01

Student Manuals:

a. Georgia, Industrial Electricity, Residential Wiring, Units RW-1a and RW-7a
b. Georgia, Electricity: Post Secondary, Unit EL-01
c. Georgia, Construction Cluster, Basic Electrical Theory, Units BET-1 through BET-10

Tools and Equipment:

(on back)

LAB HOURS 0

CLASS HOURS 60

## EVALUATION (EL-01)

Given an overview of basic electrical theory, the student will describe, diagram and define essential terms and elements, make connections and splices, identify types of flow and determine where and why each is utilized and calculate loads using Ohm's law and the power formula. All tasks must be in accordance with the instructor's specifications.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

a. Selection of wires
b. Wire strippers

## TASK

EL-02 Determining transformer polarity

## PERFORMANCE OBJECTIVE

Determine transformer polarity.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Transformers
b. Polarity of transformers
c. Test for polarity
d. Transformer operation
e. Lead identification and numbering
f. Primary
g. Secondary

Provide Demonstration On:

a. Testing of transformers
b. Lead identification and numbering

Provide Practical Application On:

a. Polarity testing of transformer
b. Testing transformer
c. Lead identification and numbering
d. Operation of transformers

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Duff, Alternating Current Fundamentals
b. Westinghouse Maintenance Hints

A/Vs:

Bergwall, "Basic Electricity and Electronics Explained - Alternating Current," filmstrip/tape

Tools and Equipment:

a. Shop tools
b. Small one phase transformer
c. VOM
d. D/C power supply
e. Single pole switch

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 10 |

## EVALUATION (EL-02)

Given a 24 volt 40VA single phase transformer and the necessary test equipment, the student will determine the polarity of the transformer and correctly identify and tag the terminals.

## TASK

EL-03 Connecting to and operating dual voltage single phase transformers

## PERFORMANCE OBJECTIVE

Connect and operate dual voltage single phase transformers.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Dual voltage transformer
b. Lead identification
c. Operation low volts (parallel)
d. Operation high volts (Series)
e. Induction
f. Primary and secondary
g. Ratio

Provide Demonstration On:

a. Dual voltage transformer
b. Lead connection (high and low volts)

Provide Practical Application On:

a. Dual voltage transformer
b. Operation (series and parallel)
c. Lead connection
d. Line connection
e. Output secondary
f. Ratio

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Dunlap, Siefert and Austin, Transformers
b. Duff, Alternating Current Fundamentals

A/Vs:

Bergwall, "Basic AC Electricity for Heat, Ventilation and Air Conditioning - Part One," film-strip/tape

Student Manuals:

Standard Electric Time Bulletin

Tools and Equipment:

a. Shop tools
b. VOM
c. Dual volt single phase transformer
d. Power supply 460/230
e. Wire nuts

**LAB HOURS** 5
**CLASS HOURS** 10

## EVALUATION (EL-03)

Given a one phase dual voltage transformer 460/230v, the necessary test equipment and power supplies, the student will accurately make the correct wiring connection for 460/230v operation and check and record all voltage readings. Secondly, the student will make the correct wiring connection for 230/115v operation and record all voltage readings. All connections and wiring must meet manufacturer's instructions and local and national code standards.

## TASK

EL-04 Connecting single phase transformers in series

## PERFORMANCE OBJECTIVE

Connect single phase transformers in series.

## INSTRUCTIONAL ACTIVITIES

**Provide Information On:**

a. Transformer in series
b. KVA rating
c. Voltage output
d. Current output
e. Series connection of transformer
f. Compatibility of transformers
g. Dual volts operation

**Provide Demonstration On:**

Series operation of transformer

**Provide Practical Application On:**

a. Transformers operating in series
b. KVA rating
c. Connecting transformers in series (low and high volts)

## INSTRUCTIONAL MATERIALS

**Textbooks:**

a. Croft, Carr and Watt, American Electrician Handbook
b. Duff, Alternating Current Fundamentals
c. Dunlap, Siefert and Austin, Transformers

**A/Vs:**

Bergwall, "Basic AC Electricity for Heat, Ventilation and Air Conditioning - Part One," filmstrip/tape

**Student Manuals:**

Standard Electric Time Bulletin

**Tools and Equipment:**

a. Shop tools
b. VOM
c. Two single phase dual volt transformers
d. Power supplies
e. Wire nuts

**LAB HOURS** 5
**CLASS HOURS** 10

## EVALUATION (EL-04)

Given two single phase dual voltage transformers and the necessary test equipment and power supplies, the student will (1) complete the required test to determine the compatibility of the transformers, (2) make the correct wiring connections for series operation of the transformers for operation from high and low voltage lines and (3) check and record all voltage readings. All connections and wiring must meet manufacturer's instructions and local and national code standards.

## TASK

EL-05 Connecting single phase transformers in parallel

## PERFORMANCE OBJECTIVE

Connect single phase transformers in parallel.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Transformers in parallel
b. KVA rating
c. Voltage output
d. Current output
e. Parallel connection of transformers
f. Compatibility of transformers
g. Low volts operation

Provide Demonstration On:

Parallel operation of transformer

Provide Practical Application On:

a. Transformers operating in parallel
b. KVA rating
c. Connections of transformers (low and high volts)

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Croft, Carr and Watt, American Electrician Handbook
b. Duff, Alternating Current Fundamentals
c. Dunlap, Siefert and Austin, Transformers

A/Vs:

Bergwall, "Basic AC Electricity for Heat, Ventilation and Air Conditioning - Parts One and Two," filmstrip/tape

Student Manuals:

Standard Electric Time Bulletin

Tools and Equipment:

a. Shop tools
b. VOM
c. Two single phase transformers (dual volt)
d. Power supplies
e. Wire nuts

| | |
|---|---|
| **LAB HOURS** | 5 |
| **CLASS HOURS** | 10 |

## EVALUATION (EL-05)

Given two single phase dual voltage transformers and the necessary test equipment and power supplies, the student will (1) make the correct wiring connections for parallel operation of the transformers from high and low voltage lines and (2) check and record all voltage readings. All connections must meet manufacturer's instructions and local and national code standards.

## TASK

EL-06 Determining the KVA rating of single phase transformers

## PERFORMANCE OBJECTIVE

Determine the KVA rating of single phase transformers.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Single phase induction motors 230v
b. KVA calculations one phase
c. Motor lead connection
d. Transformer ratings one phase
e. Transformer selection one phase
f. Transformer installation
g. Transformer connections
h. Step up/step down

Provide Demonstration On:

a. Motor hook-up
b. KVA of transformer

Provide Practical Application On:

a. Transformer installation
b. Motor operation
c. Motor installation
d. Transformer hook-up
e. Transformer sizing

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Croft, Carr and Watt, American Electrician Handbook
b. Duff, Alternating Current Fundamentals
c. Dunlap, Siefert and Austin, Transformers
d. Manufacturer's catalog

A/Vs:

Bergwall, "Basic AC Electricity for Heat, Ventilation and Air Conditioning, Parts One and Two," filmstrip/tape

Tools and Equipment:

a. One phase motor
b. Transformer
c. Power supply
d. Shop tools
e. VOM

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (EL-06)

Given a two horsepower 230v one phase induction motor and the necessary test equipment and power supplies, the student will (1) complete the necessary calculations to determine the KVA rating of a one phase transformer for operation of the motor from a 460v one phase line (2) select, install and correct the transformer and (3) connect and operate the motor from the secondary of the transformer. All work must meet local and national code standards and manufacturer's instructions for transformer installation.

## TASK

EL-07 Determining the KVA rating of three phase transformers

## PERFORMANCE OBJECTIVE

Determine the KVA rating of three phase transformers.

## INSTRUCTIONAL ACTIVITIES

### Provide Information On:

a. Three phase - power
b. Three phase induction motor 230 volts
c. KVA calculation three phase
d. Motor lead connection
e. Motor operation
f. Transformer ratings three phase
g. Transformer three phase
h. Transformer one phase bank
i. Transformer installation
j. Transformer connections
k. Step-up/step down

### Provide Demonstration On:

a. Motor hook-up
b. Three phase transformer hook-up
c. One phase transformer bank hook-up

### Provide Practical Application On:

a. Three phase motor operation
b. Three phase motor hook-up
c. Three phase transformer operation and installation
d. Three phase transformer hook-up
e. One phase transformer banks
f. Three phase power

## INSTRUCTIONAL MATERIALS

### Textbooks:

a. Croft, Carr and Watt, American Electrician Handbook
b. Dunlap, Siefert and Austin, Transformers
c. Duff, Alternating Current Fundamentals
d. Manufacturer's catalog

### A/Vs:

Bergwall, "Basic AC Electricity for Heat, Ventilation and Air Conditioning, Parts One and Two," filmstrip/tape

### Student Manuals:

Standard Electric Time Bulletin

### Tools and Equipment:

a. Three phase motor
b. Three phase transformer
c. Shop tools
d. VOM
e. Power supply
f. AC amp meter

**LAB HOURS** 5

**CLASS HOURS** 5

## EVALUATION (EL-07)

Given a two horsepower 230v three phase induction and the necessary test equipment and power supplies, the student will (1) complete the necessary calculations to determine the KVA rating of a three phase transformer bank for operation of the rating from 460v three phase lines (2) select, install and connect the transformer bank and (3) connect and operate the motor from the secondary of the transformer. All work must meet local and national code standards and manufacturer's instructions for transformer installation.

## TASK

EL-08 Hooking up and operating a one phase auto transformer

## PERFORMANCE OBJECTIVE

Hook-up and operate a one phase auto transformer.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Auto transformer
b. Operation of an auto transformer
c. Application
d. Transformer taps
e. Lead numbers
f. Lead connections
g. Ratio
h. Polarity

Provide Demonstration On:

a. Auto transformer operation
b. Transformer connection

Provide Practical Application On:

a. Auto transformer connection
b. Primary and secondary
c. Applications

## INSTRUCTIONAL MATERIALS

Textbooks:

a, Croft, Carr and Watt, American Electrician Handbook
b. Dunlap, Siefert and Austin, Transformers
c. Duff, Alternating Current Fundamentals

A/Vs:

Long Filmslide Service, "Transformers," filmstrip

Student Manuals:

Standard Eelctric Time Bulletin

Tools and Equipment:

a. Shop tools
b. Auto transformer or one phase transformer
c. VOM
d. Power supply
e. AC amp meter

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (EL-08)

Given a one phase 230/208v auto transformer and the necessary test equipment and power supplies, the student will (1) make the correct wiring connections for 208 to 230 volt operation (2) check and record all voltage readings (3) make the correct wiring connections for 230 to 208 operation (4) check and record all voltage readings and (5) make sure the correct wiring connections for 230 to 208 meet local and national code standards, and manufacturer's instructions for transformer installation.

289

## TASK

EL-09 Hooking up a one phase buck booster transformer

## PERFORMANCE OBJECTIVE

Hook-up a one phase buck booster transformer.

## INSTRUCTIONAL ACTIVITIES

**Provide Information On:**

a. Buck booster transformer
b. Operation of buck booster transformer
c. Lead connection
d. Ratio
e. Polarity

**Provide Demonstration On:**

a. Buck booster transformer
b. Buck booster transformer connection

**Provide Practical Information On:**

a. Buck booster transformer operation
b. Buck booster transformer connection

## INSTRUCTIONAL MATERIALS

**Textbooks:**

a. Dunlap, Siefert and Austin, Transformers
b. Croft, Carr and Watt, American Electrician Handbook

**A/Vs:**

Long Filmslide Service, "Transformers," filmstrip

**Student Manuals:**

Standard Electric Time Bulletin

**Tools and Equipment:**

a. Shop tools
b. One phase booster transformer
c. VOM
d. Power supply

LAB HOURS 5
CLASS HOURS 5

## EVALUATION (EL-09)

Given a single phase transformer, the necessary test equipment and power supplies, the student will (1) make the wiring connection and operate a one phase booster transformer 208/318v and (2) check and record all voltage readings. All wiring must meet local and national code standards and manufacturer's instructions for transformer installation.

## TASK

EL-10 Hooking up a three phase transformer

## PERFORMANCE OBJECTIVE

Hook-up a three phase booster transformer.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Three phase power
b. Three phase booster transformer
c. Polarity
d. Operation of booster
e. Applications
f. Connection (primary and secondary)
g. KVA rating
h. Ratio

Provide Demonstration On:

a. Three phase transformer
b. Three phase booster connection

Provide Practical Application On:

a. Three phase power
b. Three phase operation
c. Three phase booster connection (primary and secondary)

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Croft, Carr and Watt, Ameri-Electrician Handbook
b. Dunlap, Siefert and Austin, Transformers

A/Vs:

Long Filmslide Service, "Transformers," filmstrip

Student Manuals:

Standard Electric Time Bulletin

Tools and Equipment:

a. Shop tools
b. VOM
c. Three phase booster or three phase transformer
d. Power supply

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

**EVALUATION** (EL-10)

Given three single phase transformers, the necessary test equipment, and power supplies, the student will (1) make the proper wiring connections and operate a three phase booster transformer 208/312 and (2) check out and record all voltage readings. All wiring must meet local and national code standards and manufacturer's instructions for transformer installation.

## TASK

EL-11 Hooking up a three phase auto transformer

## PERFORMANCE OBJECTIVE

Hook-up a three phase auto transformer.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Auto transformer three phase
b. Ratio
c. Lead marking
d. Operation
e. Application
f. Wye connection
g. Delta connection

Provide Demonstration On:

a. Application
b. Lead connection of three phase auto transformer
c. Wye connection
d. Delta connection
e. Three phase auto transformer
f. Wye connection of auto transformer
g. Delta connection of auto transformer
h. Connections line and load

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Croft, Carr and Watt, American Electrician Handbook
b. Duff, Alternating Current Fundamentals
c. Dunlap, Siefert and Austin, Transformers

A/Vs:

Long Filmslide Service, "Transformers," filmstrip

Student Manuals:

Standard Electric Time Bulletin

Tools and Equipment:

a. Shop tools
b. Three one phase transformer
c. VOM
d. Power supply

LAB HOURS 5

CLASS HOURS 5

## EVALUATION (EL-11)

a. Given three one phase three KVA dual voltage transformers, the necessary test equipment and power supplies, the student will (1) make the wiring connections and operate a three phase auto transformer bank 208/104 volts and (2) check and record all voltage readings. All wiring must meet local and national code standards and manufacturer's instuctions for installation.

b. Given three one phase three KVA dual voltage transformers, the necessary test equipment and power supplies, the student will (1) make the wiring connections and operate a three phase Delta connected auto transformer bank and (2) check and record all voltage readings. All wiring must meet local and national code standards and manufacturer's instructions for transformer installation.

## TASK

EL-12 Hooking up a three phase transformer bank connected Wye/Wye

## PERFORMANCE OBJECTIVE

Hook-up a three phase transformer connected Wye/Wye.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Transformer operation
b. Wye connection (3 wire, 4 wire)
c. Primary winding connection
d. Ratio
e. Applications

Provide Demonstration On:

a. Wye connection three and four wire
b. Three phase loads
c. One phase load
d. Balance of loads
e. Neutral loads

Provide Practional Application On:

a. Wye transformer connection
b. High volts three and four wire
c. Low volts three and four wire
d. Three phase loads operation
e. One phase loads operation
f. Neutral loads

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Duff, Alternating Current Fundamentals
b. Dunlap, Siefert and Austin, Transformers

A/Vs:

Long Filmslide Service, "Transformers," filmstrip

Student Manuals:

Standard Electric Time Bulletin

Tools and Equipment:

a. Shop tools
b. Dual volts transformers (3)
c. VOM
d. Power supplies
e. Resistive load banks
f. AC amp meter

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 10 |

## EVALUATION (EL-12)

a. Given three one phase three KVA dual voltage transformers, the necessary test equipment and power supplies, the student will (1) make the wiring connections and operate a three phase bank connected Wye/Wye (2) operate at high and low volts three phase three wire and three phase four wire and (3) check and record all voltage readings. All wiring must meet local and national code standards and manufacturer's instructions for transformer installation.

b. The student will test the above with a balanced resistive load.

c. The student will test the above with an unbalanced resistive load.

## TASK

EL-13 Hooking up a three phase transformer bank connected Delta/Delta

## PERFORMANCE OBJECTIVE

Hook-up a three phase transformer bank connected Delta/Delta.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Isolated
b. Grounded
c. Point of grounded connection
d. Red lead
e. Ratio
f. Step up/step down
g. Current one voltage in a Delta connection
h. Voltage to ground
i. Applications
j. Load balance three phase
k. Single phase loads

Provide Demonstration On:

a. Delta/Delta operation
b. Three and four wire secondary connections
c. Loads from secondary
d. Balanced loads

Provide Practical Application On:

a. Delta connected transformers
b. Wiring connections
c. Low and high volts operation
d. Balance loads
e. Three and four wire secondary connections
f. Neutral loads

(Continued on back)

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Duff, Alternating Current Fundamentals
b. Dunlap, Siefert and Austin, Transformers

A/Vs:

Long Filmslide Service, "Transformers," filmstrip

Student Manuals:

Standard Electric Time Bulletin

Tools and Equipment:

a. Three dual volt
b. Shop tools
c. VOM
d. AC amp meter
e. Resistive load banks

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 10 |

## EVALUATION (EL-13)

Given three one phase three KVA dual voltage transformers, the necessary test equipment and power supplies, the student will (1) make the wiring connections and operate a three phase bank connected Delta/Delta (2) operate at high and low volts three phase three wire and three phase four wire and (3) check and record all voltage readings. All wiring must meet local and national code standards and manufacturer's instructions for installation.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

g. Isolated transformer
h. Grounded transformer
i. Three phase loads from secondary
j. One phase loads from secondary

## TASK

El-14 Hooking up a three phase bank of transformers open Delta

## PERFORMANCE OBJECTIVE

Hook-up a three phase bank of transformers connected open Delta.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Open Delta
b. Three phase using two single phase transformers
c. Load capability
d. Grounded
e. Isolated
f. Point of grounding
g. Red lead
h. Load balance
i. Single phase loads
j. Ratio
k. Step up/step down

Provide Demonstration On:

a. Open Delta operation
b. Load capability
c. Grounding
d. High leg (red lead)
e. Load balance

Provide Practical Application On:

a. Hooking up transformers 3 and 4 wire
b. Three phase loads
c. Load balance
d. Point of grounding
e. Load capability

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Duff, Alternating Current Fundamentals
b. Dunlap, Siefert and Austin, Transformers

A/Vs:

Long Filmslide Service, "Transformers," filmstrip

Student Manuals:

Standard Electric Time Bulletin

Tools and Equipment:

a. Shop tools
b. Two single phase dual volt transformers
c. VOM
d. AC amp meter
e. e phase loads
f. 1 phase loads

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 10 |

## EVALUATION (EL-14)

Given two one phase transformers, dual voltage transformer, the necessary test equipment and power supplies, the student will (1) make the wiring connections and operate a three phase bank connected open Delta (2) operate at high and low volts three phase three wire and three phase four wire and (3) check and record all voltage readings. All wiring and connections must meet local and national code standards and manufacturer's instructions for installation.

(NOTE: The center top of the secondary of this transformer is not usually grounded when the transformer bank is operating at low voltage).

## TASK

EL-15 Hooking up a three phase transformer bank connected Wye/Delta

## PERFORMANCE OBJECTIVE

Hook-up a three phase tranformer bank connected Wye/Delta.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Wye/Delta connection
b. Wye/Delta operation
c. Transformer ratio
d. Primary connection
e. Secondary connection
f. Applications

Provide Demonstration On:

a. Wye/Delta operation
b. Ratio - volts and current
c. Wye/Delta connection

Provide Practical Application On:

a. Wye Delta connection
b. Transformer ratio
c. (Series) high volts operation
d. (Parallel) low volts operation

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Duff, Alternating Current Fundamentals
b. Dunlap, Siefert and Austin, Transformers

A/Vs:

Long Filmslide Service, "Transformers," filmstrip

Student Manuals:

Standard Electric Time Bulletin

Tools and Equipment:

a. Shop tools
b. Three one phase transformers
c. VOM
d. Power supplies
e. AC amp meter
f. Resistive loads

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 10 |

## EVALUATION (EL-15)

Given three one phase dual voltage transformers, the necessary test equipment and power supplies, the student will (1) make the wiring connections and operate a three phase bank connected Wye/Delta, (2) operate at high and low voltage three phase three wire and (3) check and record all voltage readings. All wiring must meet local and national code standards and manufacturer's instructions for installation.

## TASK

EL-16 Hooking up a three phase transformer bank connected Delta-Wye

## PERFORMANCE OBJECTIVE

Hook-up a three phase transformer bank connected Delta/Wye.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Transformer operation
b. Transformer ratio
c. Primary connection
d. Secondary connection
e. High volts connection
f. Low volts connection
g. Application

Provide Demonstration On:

a. Transformer connection
b. Transformer ratio

Provide Practical Application On:

a. Transformer connection
b. Transformer ratio
c. Primary connection
d. Secondary connection
e. Series connection (high volts)
f. Parallel connection (low volts)

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Duff, Alternating Current Fundamentals
b. Dunlap, Siefert and Austin, Transformers

A/Vs:

Long Filmslide Service, "Transformer," filmstrip

Student Manuals:

Standard Electric Time Bulletin

Tools and Equipment:

a. Shop tools
b. Three one phase transformers
c. VOM
d. AC amp meter
e. Resistive loads
f. Power supplies

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 10 |

# EVALUATION (EL-16)

Given three one phase dual voltage transformers, the necessary test equipment and power supplies, the student will (1) make the wiring connections and operate a three phase bank connected Delta/Wye, (2) operate a three phase three wire and three phase four wire and (3) check and record all voltage readings. All wiring must meet local and national code standards and manufacturer's instructions for installation.

## TASK

EL-17 Hooking up a three phase transformer bank; reversed voltage

## PERFORMANCE OBJECTIVE

Hook-up a three phase transformer bank connected reversed voltage.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Three phase from two phase lines
b. Reversed voltage
c. Transformer operation
d. Neutral connection
e. Primary connection
f. Secondary connection
g. Applications

Provide Demonstration On:

a. Reversed voltage operation
b. Three phase from two phase lines

Provide Practical Application On:

a. Transformer operation
b. Transformer connection
c. Three phase from two phase lines
d. Transformer load capability

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Duff, Alternating Current Fundamentals
b. Dunlap, Siefert and Austin, Transformers
c. Penden and Del-Mar, Electrical Engineer's Handbook

A/Vs:

Long Fimslide Service, "Transformers," filmstrip

Student Manuals:

Standard Electric Time Bulletin

Tools and Equipment:

a. Two single phase transformers
b. Shop tools
c. VOM
d. AC amp meter
e. Power supply
f. Resistive loads

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 10 |

## EVALUATION (EL-17)

Given two one phase dual voltage transformers, the necessary test equipment and power supplies, the student will (1) make the necessary wiring connections for operation of a three phase three wire open/Delta connected secondary (2) connect the primary to two phase lines of a three phase power supply (3) operate the transformer bank at high voltage and (4) check and record all voltage readings. All wiring must meet local and national code standards and manufacturer's instructions for installation.

## TASK

EL-18 Hooking up transformers for special applications

## PERFORMANCE OBJECTIVE

Hook-up transformers for special applications.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Special transformer application
b. Three phase four-wire distribution
c. Three phase interconnected wye
d. Six phase six wire
e. Six phase six wire double Delta
f. Scott three phase to two phase three wire
h. Tee connection three phase three wire
i. Synchronous rotary converter
j. Rotary converter

Provide Demonstration On:

a. Three phase inter-connected wire
b. Six phase six wire
c. Six phase six wire Double Delta
d. Scott three phase to two phase three and four wire
e. Tee connection

Provide Practical Application On:

a. Special tranformer application
b. Three phase four wire distribution
c. Three phase inter-connected wye

(Continued on back)

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Duff, Alternating Current Fundamentals
b. Penden and Del-Mar, Electrical Engineer's Handbook
c. Dunlap, Siefert and Austin, Transformers
d. Croft, Carr and Watt, American Electrician Handbook

A/Vs:

Long Filmslide Service, "Transformers," filmstrip

Student Manuals:

Standard Electric Time Bulletin

Tools and Equipment:

a. Shop tools
b. Proper transformer

LAB HOURS 5

CLASS HOURS 10

## EVALUATION (EL-18)

Given three one phase three KVA transformers, the necessary test equipment and power supplies, the student will (1) make the necessary wiring connections and operate a three phase transformer bank connected as the following:

1. 208v three phase four wire wye distribution
2. 360v three phase with neutral (inter-connected wye) for three phase rotary connector
3. 105v six phase six phase rotary connector
4. 120v six phase six wire double delta
5. Scott connection three phase to two phase four wire
6. Scott connection three phase to three phase three wire
7. Tee connection three phase three wire

and (2) check and record all voltage readings. All wiring must meet local and national code standards and manufacturer's instructions for installation.

### INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

d. Six phase six wire
e. Six phase six wire double Delta
f. Scott three phase to two phase four wire
g. Scott three phase to two phase three wire
h. Tee connection three phase three wire
i. Synchronous rotary converter
j. Rotary converter

## TASK

EL-19 Calculating service load for a small commercial building

## PERFORMANCE OBJECTIVE

Calculate service load for a small commercial building.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. General lighting loads
b. Types of lighting
c. Special lighting loads
    1. Decorative
    2. Show window
    3. Night lights
    4. Emergency light
    5. Exit lights
d. General purpose outlets
e. Specific purpose outlets
f. Motor loads
g. Calculations for each of the above

Provide Demonstration On:

Load calculations for general lighting, special lighting, general and special purpose outlets and motor loads

Provide Practical Application On:

a. Load calculations
b. Total load calculations

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Ramsey and Sleeper, Architectural Graphic Standard
b. Building specifications
c. Croft, Carr and Watt, American Electricians Handbook
d. Summers, National Electrical Code
e. Heine, Dunlap and Jones, Electrical Blueprints

A/Vs:

Bergwall, "Planning and Roughing In," filmstrip/tape

Student Manuals:

Georgia, Industrial Electricity, Commercial Wiring, Unit CW-1

Tools and Equipment:

a. Set of prints
b. Scale
c. Shop tools
d. Specifications
e. Fixture catalog
f. Motor catalog
g. NEC
h. Fixture schedule

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 10 |

## EVALUATION (EL-19)

Given a complete set of drawings for a commercial building, the student will calculate the total connected electrical service load. Calculations must be within 2% of correct answers. Power company service will be 115/230v three phase four wire Delta. The student will show all calculations.

## TASK

EL-20 Locating service entrance equipment and writing specifications

## PERFORMANCE OBJECTIVE

Locate service entrance equipment and write specifications.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Location of service entrance equipment
b. Selection of service entrance equipment
c. Writing of specifications
d. Service entrance wire selection
e. Conduit selection
f. Conduit bending installation
g. Grounding of service

Provide Demonstration On:

a. Wire selection
b. Conduit selection
c. Conduit bending installation

Provide Practical Application On:

a. Conduit bending installation
b. Conduit selection
c. Write the service entrance specifications
d. Selection of service equipment

(Continued on back)

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Ramsey and Sleeper, Architectural Graphic Standard
b. Graham, Industrial and Commercial Wiring
c. Summers, National Electrical Code

A/Vs:

a. Singer Career Systems, "Electric Wire and Cable," filmstrip/tape; "Electrical Boxes," filmstrip/tape

(Continued on back)

Student Manuals:

Georgia, Industrial Electricity, Commercial Wiring, Unit CW-2

Tools and Equipment:

a. Complete set of prints
b. Specifications
c. Power company regulations
d. NEC

LAB HOURS 5

CLASS HOURS 5

## EVALUATION (EL-20)

Given a complete set of prints, specifications and power company regulations, the student will accurately (1) complete the necessary calculations to determine the type and size of service equipment (2) select the correct service entrance equipment, the necessary tools and materials and (3) install the service equipment for a small commercial facility. The student will follow these steps

1. Mount the three phase four wire service equipment on backboards secured to a concrete block wall.
2. Make the necessary bends and install service entrance conduits.
3. Install the service entrance and grounding conductors.
4. Connect to service equipment.
5. Connect service to a 115/230 three phase four wire Delta power supply.
6. Operate and test all equipment.

All wiring must meet local and national code standards.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

e. Installation of service equipment
f. Location of service entrance equipment
g. Grounding of service

INSTRUCTIONAL MATERIALS

A/Vs:

AAVIM, "Electrical Wiring Residential - Utility Buildings - Service Areas," slide/tape

## TASK

EL-21 Selecting a service entrance conductor

## PERFORMANCE OBJECTIVE

Select a service entrance conductor.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Copper conductors
b. Conductor insulation
c. Alum conductors
d. Single conductors
e. Conductors in parallel
f. Temperature rating

Provide Demonstration On:

Conductor selection

Provide Practical Application On:

Conductor selection

## INSTRUCTIONAL MATERIALS

Textbooks:

Summers, National Electrical Code

A/Vs:

AAVIM, "Electrical Wiring Residential - Utility Buildings - Service Areas," slide/tape

Student Manuals:

Georgia, Industrial Electricity, Commercial Wiring, Units CW-3 and CW-3a

Tools and Equipment:

a. NEC
b. Equipment catalog

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 5 |

## EVALUATION (EL-21)

Given the service rating, the student will complete the necessary calculations to determine the best conductor selection for the service entrance.

1. Single copper conductor
2. Parallel copper conductor
3. Single aluminum conductor
4. Parallel aluminum conductor

## TASK

EL-22 Calculating service conduits

## PERFORMANCE OBJECTIVE

Calculate service conditions.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types of conduit
b. Size of conduit
c. Parallel conduits
d. Numbers of conductors in conduit
e. Supporting conduit

Provide Demonstration On:

a. Conduit selection
b. Conduit percent fill

Provide Practical Application On:

Conduit selection

## INSTRUCTIONAL MATERIALS

Textbooks:

Summers, National Electrical Code

A/Vs:

a. Singer Career Systems, "Electrical Service Entrance," filmstrip/tape
b. AAVIM, "Electrical Wiring Residential - Utility Buildings - Service Areas," slide/tape

Student Manuals:

Georgia, Industrial Electricity Commercial Wiring, Unit CW-3

Tools and Equipment:

a. NEC
b. Supply catalog
c. Equipment catalog
d. Set of prints
e. Scale

**LAB HOURS** 5

**CLASS HOURS** 5

## **EVALUATION** (EL-22)

From a given set of prints, the student will complete the necessary calculations to determine the type and size of service conduits to be installed. All work must meet local and national electric code standards.

## TASK

EL-23 Installing service conduits

## PERFORMANCE OBJECTIVE

Install service conduits.

## INSTRUCTIONAL ACTIVITIES

**Provide Information On:**

a. Conduit bending
b. Conduit installing

**Provide Demonstration On:**

Conduit bending

**Provide Practical Application On:**

Conduit bending and installing

## INSTRUCTIONAL MATERIALS

**Textbooks:**

Summers, *National Electrical Code*

**A/Vs:**

AAVIM, "Electrical Wiring Residential-Utility Buildings-Service Areas," slide/tape

**Student Manuals:**

Georgia, *Industrial Electricity, Commercial Wiring*, Unit CW-3a

**Tools and Equipment:**

a. *NEC*
b. Set of prints
c. Shop tools
d. Conduit
e. Benders
f. Straps
g. Screws, nuts, bolts, etc.

**LAB HOURS** 10

**CLASS HOURS** 5

## EVALUATION (EL-23)

From a given set of prints, the student will

1. Select the proper type of conduits
2. Show (layout) the service conduits on the set of prints
3. Show the size of conduit needed for the service
4. Show the size of conduits to be used in parallel for the service
5. Make the necessary bends, install and support the conduit

All work must meet local and national codes.

## TASK

EL-24 Installing service entrance conductors

## PERFORMANCE OBJECTIVE

Install service entrance conductors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Conductors
  1. Types
  2. Sizes
  3. Ampacity
  4. Copper vs aluminum
b. Number of conductors in a conduit
c. Parallel
d. Cost
e. Grounding service

Provide Demonstration On:

Conductor selection

Provide Practical Application On:

a. Conductor selection
b. Conductor installation

## INSTRUCTIONAL MATERIALS

Textbooks:

Summers, National Electric Code

A/Vs:

a. Singer Career Systems, "Electrical Service Entrance," filmstrip/tape
b. AAVIM, "Electrical Wiring Residential-Utility Buildings-Service Areas," slide/tape

Student Manuals:

Georgia, Industrial Electricity, Commercial Wiring, Unit CW-3a

Tools and Equipment:

a. Set of prints
b. Shop tools
c. Fish tape
d. Wire tube
e. Wire

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 10 |

## EVALUATION (EL-24)

From a given set of prints, the student will complete the necessary calculations to determine the proper size and type of service conductors and grounding. The student will select and install these conductors in the conduits. All work must meet local and national electric codes.

## TASK

EL-25 Selecting and installing meters

## PERFORMANCE OBJECTIVE

Select and install meters.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Meter types
b. Meter sockets
c. Size and type meter for different service
d. Metering equipment

Provide Demonstration On:

a. CT installation
b. Meter installation

Provide Practical Application On:

Metering installation
1. CT
2. In-line

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Summers, National Electrical Code
b. Equipment catalog

A/Vs:

Singer Career Systems, "Reading Electric Meters," filmstrip/tape

Student Manuals:

Georgia, Industrial Electricity, Commercial Wiring, Unit CW-4

Tools and Equipment:

a. Meter bases
b. Shop tools
c. Conduits
d. Cutters
e. Threaders
f. Power company regulation
g. NEC

**LAB HOURS** 5

**CLASS HOURS** 5

## EVALUATION (EL-25)

Given appropriate equipment, the student will select and install the correct measuring devices for a given service entrance according to power company regulations. The meter may be CT or in-line (CT for any service larger than 200 amps, in-line for any service less than 200 amps). All work must meet local and national codes.

323

## TASK

EL-26 Selecting and installing panels

## PERFORMANCE OBJECTIVE

Select and install panels.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Panel ratings
b. Panel selection
c. Panel spacing and working space

Provide Practical Application On:

a. Load calculation to determine
b. Service equipment size
c. Service equipment selection
d. Panel installation and connection

## INSTRUCTIONAL MATERIALS

Textbooks:

Summers, National Electrical Code

Student Manuals:

Georgia, Industrial Electricity, Commercial Wiring, Unit CW-4

Tools and Equipment:

a. Given load
b. Shop tools
c. Equipment catalog
d. NEC
e. Conductors
f. 208v 3 phase 4 wire power supply
g. 480v 3 phase 4 wire power supply

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (EL-26)

For a given load the student will select, install and make wiring connections for a 480v 3 phase 4 wire service, following these steps

1. List catalog number for the panel
2. Outline in detail the procedure for determining bus length
3. List by catalog number the breakers required
4. Change the load to 208v 3 phase 4 wire and list the same information

## TASK

EL-27 Calculating and installing motor branch circuits

## PERFORMANCE OBJECTIVE

Calculate and install motor branch circuits.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Motor nameplate information
b. Locked rotor KVA
c. Code letters
d. Manual starters
e. Magnetic starters
f. Branch circuit overcurrent protection
g. Motor running overcurrent protection
h. Motor branch circuit conductor selection
i. Motor controls

Provide Demonstration On:

Motor branch circuit calculation

Provide Practical Application On:

a. Motor branch circuit calculation
b. Motor branch circuit installation

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Rosenberg, Electric Motor Repair
b. Summers, National Electrical Code
c. Graham, Industrial and Commercial Wiring
d. Veinott, Horsepower Electric Motors
e. Croft, Carr and Watt, American Electrician Handbook

Student Manuals:

Square D Manual

Tools and Equipment:

a. Equipment catalog
b. 3 phase motor
c. Motor controls
d. Shop tools
e. Meter Vom
f. Amp meter a/c

(Continued on back)

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (EL-27)

a. Given a set of prints showing the location of service equipment, a 15 h.p. 230 volt 3 phase induction motor code F and the necessary test equipment and power supply, the student will complete the necessary calculations to determine
   1. Motor branch circuit conductors size and type
   2. Motor running overload protection
   3. Branch circuit overcurrent protection

   Calculations must be based on national code standards and should be 100% accurate.

b. After completing the above, the student will (1) select the required material (2) install the conduits and controls on a plywood back board (3) install branch circuits and control wiring (4) complete all wiring connections (5) test the circuitry and (6) connect to a power supply and operate first the manual and the magnetic controls. All work must meet local and national code standards.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

g. Wiring material
h. Set of prints
i. Power supply
j. VOM
k. Amp meter

## TASK

EL-28 Installing and operating subfeeders and panels

## PERFORMANCE OBJECTIVE

Install and operate subfeeders and panels.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Subfeeders
b. Panels
c. Rules governing the selection and installation of subfeeders
d. Location of sub panels

Provide Practical Application On:

a. Installation of sub panels
b. Installation of subfeeder
c. Selection of conductors
d. Selection of sub panels

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Summers, National Electrical Code
b. Croft, Carr and Watt, American Electrician Handbook
c. Graham, Industrial and Commercial Wiring

Tools and Equipment:

a. Set of prints
b. Shop tools
c. Conduit and benders
d. Panel
e. Power supply
f. Vom
g. Amp meter

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (EL-28)

From a given set of prints, the student will (1) show the location of all service equipment and (2) select the required material and install and operate a 100 3 phase 4 wire amp MLO subpanel. Disconnect and overcurrent should be provided in main distribution equipment. Subpanel should be surface mounted and wired using ridgid conduit on a plywood backboard. Location of panel on board must be within one-eighth inch of specified measurement.

## TASK

EL-29 Grouping outlets onto branch circuits

## PERFORMANCE OBJECTIVE

Group outlets onto branch circuits.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Grouping outlets onto branch circuits
b. Types of branch circuits
c. Number of conductors per conduit

Provide Practical Application On:

a. Calculating branch circuit loads
b. Grouping these outlets onto branch circuits according to nature of loads
c. Correcting branch circuits overcurrent
d. Showing all conduits and home runs

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Croft, Carr and Watt, American Electrician Handbook
b. Summers, National Electrical Code

A/Vs:

Singer Career Systems, "Installing Electrical Boxes and Conduit," filmstrip/tape

Student Manuals:

Georgia, Industrial Electricity, Commercial Wiring, Unit CW-5

Tools and Equipment:

Set of prints showing outlets and loads

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (EL-29)

Given a floor plan of a commercial building, the student will

1. Show the locations of all general and special purpose outlets
2. Group these outlets onto branch circuits according to nature of loads
3. Show all conduit home runs on prints

All wiring methods must meet local and national code standards.

## TASK

EL-30 Installing specific purpose outlets

## PERFORMANCE OBJECTIVE

Install specific purpose outlets.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Electrical device selection and installation
b. Specific branch circuit
c. Device rating

Provide Demonstration On:

Electrical device selection

Provide Practical Application On:

Material selection and installation of a specific branch circuit

## INSTRUCTIONAL MATERIALS

Textbooks:

Summers, National Electrical Code

A/Vs:

Bergwall, "Finishing the Installation," filmstrip/tape

Tools and Equipment:

a. Print
b. NEC
c. Ship tools
d. Electrical devices
e. Conduit
f. Boxes
g. Wiring material
h. Conduit benders
i. VOM
j. Power supply

**LAB HOURS** 5

**CLASS HOURS** 5

## EVALUATION (EL-30)

Given the requirements for a specific branch circuit in a commercial building, the student will
1. Select the correct conduit
2. Select the correct branch circuit conductors
3. Select the correct branch circuit overcurrent protection device
4. Select the correct boxes and fittings
5. Select the correct devices for the circuit
6. List the material
7. Install the circuit

All work must meet local and national code standards.

## TASK

EL-31 Calculating branch circuit conductors and overcurrent protection

## PERFORMANCE OBJECTIVE

Calculate branch circuit conductors and overcurrent protection.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Branch circuit overcurrent protection
b. Type of branch circuit conductor
c. Number of conductors per branch circuit
d. Branch circuit conductor size
e. Branch circuit wiring installation and connection to overcurrent and loads

Provide Demonstration On:

a. Load calculations
b. Wire selection (type and size)
c. Branch circuit conductor installation and connection

Provide Practical Application On:

a. Calculating the load on branch circuits
b. Selecting correct wire size to be installed
c. Selecting proper type of conductors

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Summers, National Electrical Code
b. Carr, Croft and Watt, American Electrician Handbook

A/Vs:

Singer Career Systems, "Circuit Breakers," filmstrip/tape

Student Manuals:

Georgia, Industrial Electricity, Commercial Wiring, Unit CW-5

Tools and Equipment:

a. Set of prints
b. NEC
c. Wire
d. Power supply (panel)

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (EL-31)

Given a floor plan of a commercial building, the student will accurately (1) make the necessary calculation to determine the size and type of branch circuit conductors to be installed and the branch circuit overcurrent protection for these circuits and (2) show all work and list material selection on prints. All calculations must meet or exceed local and national code standards.

## TASK

EL-32 Installing branch circuits and controls for lighting

## PERFORMANCE OBJECTIVE

Install branch circuits and controls for lighting.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. General illumination
b. Fluorescent lighting
c. Exit lights
d. Night lights
e. Emergency lights
f. Show window lighting
g. Lighting branch circuits
h. Control of lighting
i. Installing fixtures
j. Grouping lights onto branch circuits
k. Layout of lights (arrangment)
l. Amount of lights (lumens)

Provide Practical Application On:

a. Lighting branch circuit installation
b. Installation of controls
c. Branch circuit calculation
d. Fixture installation
e. Group fixtures onto branch circuits
f. Amount of required light (lumens)

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Graham, Industrial and Commercial Wiring
b. Summers, National Electrical Code
c. Croft, Carr and Watt, American Electrician Handbook

A/Vs:

Bergwall, "Planning and Roughing In," filmstrip/tape

Tools and Equipment:

a. Set of prints
b. Mat catalog
c. Wiring material
d. Shop tools
e. VOM
f. Power supply

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (EL-32)

a. Given a set of prints showing branch circuits and equipment for lighting and lighting control, the student will select the required material for installing the specificied branch circuits and controls for (1) general illumination, (2) exit lights, (3) night lights, (4) show window lighting and (5) emergency lighting. All equipment and material selection must meet local and national code standards.

b. The student will accurately (1) group the lights onto branch circuits (2) show all work on the print and (3) complete a material selection list.

c. The student will install and operate a circuit which has one of each of the lights (listed in a) with controls.

All work must meet local and national code standards.

## TASK

EL-33 Selecting conduit

## PERFORMANCE OBJECTIVE

Select conduit.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Overhead conduits
b. Under slab conduits
c. Number of conductors per conduit

Provide Demonstration On:

a. Conduit types
b. Conduit sizes
c. Percent fill of conduits

Provide Practical Application On:

Conduit selection

## INSTRUCTIONAL MATERIALS

Textbooks:

Summers, National Electrical Code

Student Manuals:

Georgia, Industrial Electricity, Commercial Wiring, Unit CW-6

Tools and Equipment:

NEC

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (EL-33)

a. Given a floor plan of a commercial building, the student will accurately select the size and type conduit to be installed as branch circuit raceways (overhead and under slab) and show all conduit home runs, size and types on prints.

b. All material selection and sizes must be based on national code and standards.

## TASK

EL-34 Installing conduit under a concrete slab

## PERFORMANCE OBJECTIVE

Install conduit under a concrete slab.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Floor boxes
b. Material selection
c. Installation of under floor conduits
d. Floor elevations

Provide Demonstration On:

Securing conduits

Provide Practical Application On:

a. Floor box installation
b. Material selection
c. Installing conduits under a slab

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Summers, National Electrical Code
b. Croft, Carr and Watt, American Electrician Handbook
c. Graham, Industrial and Commercial Wiring

Student Manuals:

Georgia, Industrial Electricity, Commerical Wiring, Unit CW-7

Tools and Equipment:

a. Set of prints showing floor outlets
b. Shop tools
c. Conduits, benders and tools
d. NEC

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (EL-34)

Given an electrical plan showing location of floor outlets and finish floor grades, the student will accurately select the necessary material, set the floor boxes to grade and install the conduit runs. All boxes and conduits must be secure to prevent dislocation while concrete floor is being poured. All work must meet local and national code standards.

## TASK

EL-35 Installing outlet, junction and conduitlets

## PERFORMANCE OBJECTIVE

Install the necessary conduitlets and boxes for conduit runs.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Boxes and conduitlets
b. Number of conductors per each
c. Number of conduits per each
d. Outlet and junction location
e. Conduit bending and installation
f. Conduit support
g. Conduits in masonary walls
h. Conduit exposed on masonary walls
i. Branch circuits

Provide Demonstration On:

a. Boxes and selection
b. Conduit bending
c. Conduit installation

Provide Practical Application On:

a. Boxes and conduitlet installation
b. Conduit bending
c. Conduit installation

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Croft, Carr and Watt, American Electrician Handbook
b. Graham, Industrial and Commercial Wiring
c. Summers, National Electrical Code

Tools and Equipment:

a. Set of prints
b. Shop tools
c. Conduit and fittings
d. Boxes
e. Conduit benders
f. Wire
g. Fish tape

**LAB HOURS** 5
**CLASS HOURS** 5

## EVALUATION (EL-35)

Given a set of prints showing panel and outlet locations, the student will accurately select the proper materials, mount the required boxes and conduitlets, make the necessary conduit bends and install the conduit runs. All boxes, outlets and fittings must be within one fourth inch of specifications. The student will install the branch circuit conductors and make the required wiring connection for complete installation of branch circuits. The student will also operate and test wiring. All work must meet local and national code standards.

## TASK

EL-36 Installing branch circuits and controls for air conditioning and heating

## PERFORMANCE OBJECTIVE

Install branch circuits and controls for air conditioning and heating.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. EMT conduit
b. EMT bending
c. Motor starters and control
d. Motor starter selection and installation
e. Branch circuit and feeder calculation

Provide Demonstration On:

a. EMT bending and installation
b. Motor starter installation
c. Control selection

Provide Practical Application On:

a. EMT conduit bending
b. Motor starter installation
c. Control hook-up
d. Branch circuit mat selection and installation

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Summers, National Electrical Code
b. Croft, Carr and Watt, American Electrician Handbook
c. Graham, Industrial and Commercial Wiring
d. Althouse, Turnquist and Bracciano, Modern Refrigeration and Air Conditioning

Tools and Equipment:

a. Set of prints
b. Shop tools
c. EMT conduit
d. Conductors
e. Motor starters
f. Power supply
g. VOM
h. Amp meter

(Continued on back)

LAB HOURS 5

CLASS HOURS 5

## EVALUATION (EL-36)

Given a set of prints showing the locations and ratings of electric heating and cooling equipment, the student will (1) complete the necessary calculations to determine the branch circuit and feeder requirements based on National Electrical Code standards and (2) select material and install and operate the required branch circuits and equipment. Branch circuits wiring must be installed in proper size EMT conduit. All equipment must be mounted on three-fourth inch plywood backboard within one-eighth inch of specified measurement. All work must meet local and national code standards.

INSTRUCTIONAL MATERIALS

A/Vs:

Bergwall, "Basic AC Electricity for Heat, Ventilation and Air Conditioning - Part One," filmstrip/tape

## TASK

EL-37 Selecting and installing branch circuits for three phase water heaters

## PERFORMANCE OBJECTIVE

Select and install branch circuits for three phase water heaters.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Three phase loads Delta and Wye
b. Three phase branch circuits
c. Material selection
d. Branch circuit overcurrent protection selection and installation
e. Disconnect
f. Load calculations
g. Three phase branch circuits from panels

Provide Demonstration On:

a. Three phase loads Delta and Wye
b. Three phase branch circuits
c. Load calculations

Provide Practical Application On:

a. Loal calculations
b. Branch circuit material
c. Selection
d. Branch circuit installation
e. Connection to three phase load

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Summers, National Electrical Code
b. Croft, Carr and Watt, American Electrician Handbook
c. Graham, Industrial and Commercial Wiring
d. Manufacturer's catalog

A/Vs:

Bergwall, "Finishing the Installation," filmstrip/tape

Tools and Equipment:

a. Set of prints
b. Branch circuit material
c. Power supply
d. Shop tools
e. VOM
f. Amp meter

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (EL-37)

Given a set of prints showing the location and rating of a three phase 230v electric water heater, and given access to material and equipment, the student will (1) complete all necessary calculations to determine the branch circuit capacity necessary for proper operation of the water heater and (2) select, install and operate the branch circuit. Wiring will be installed in EMT mounted on a concrete block wall. All equipment must be mounted within one-fourth inch of drawing specifications. All work must meet local and national code standards.

## TASK

EL-38 Planning and performing site work for a small industrial facility

## PERFORMANCE OBJECTIVE

Plan and perform site work for a small industrial facility.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Location of utilities on building site
b. Location of building on plot plan
c. Property lines
d. Prepare location of electrical service
e. Voltage and transformer bank for industrial service
f. Overhead and underground service installation

Provide Demonstration On:

a. Voltage and KVA rating of transformers
b. Transformer hook-up
c. Overhead and underground service entrance
d. Transformer installation

Provide Practical Application On:

a. Planning site work
b. The location and installation of service equipment as per specifications and NEC
c. Transformer hook-ups and installations

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Croft, Carr and Watt, American Electrician Handbook
b. Graham, Industrial and Commercial Wiring
c. Summers, National Electrical Code

A/Vs:

Bergwall, "Planning and Roughing In," filmstrip/tape

Tools and Equipment:

a. Set of prints
b. Set of specifications
c. Engineer scale

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (EL-38)

From a given set of prints and the electrical specifications, the student will accurately determine

a. Service locations
b. Service overhead/underground
c. Location of transformer
d. Proper bank of transformers
e. The correct service voltage
f. Any conflicts with other utilities

## TASK

EL-39 Making calculations for electric motors, welders and heaters

## PERFORMANCE OBJECTIVE

Make calculations for electric motors, welders and heaters.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Motor nameplate information
b. Single phase motors
c. Three phase motors
d. Three phase and single phase motor operations
e. Welder nameplate information
f. Single phase welders
g. Three phase welders
h. Welder operation
i. NEC article 430, 630, 220, 424
j. Heater nameplate information
k. Single phase electric heaters
l. Three phase electric heaters

Provide Demonstration On:

a. Operating single phase and three phase motor and welders
b. Motor nameplate information
c. Welder nameplate information
d. Operating single and three phase heaters
e. Heater nameplate information
f. Load calculations

Provide Practical Application On:

a. Motor branch circuit and feeder calculations

(Continued on back)

## INSTRUCTIONAL MATERIALS

Textbooks:

Summers, National Electrical Code

A/Vs:

Hobar, "Electric Motors: Enclosures, Bearings and Mounting Methods," slide/tape

Tools and Equipment:

a. Set of prints with motor and welder load
b. NEC

LAB HOURS 5
CLASS HOURS 5

## EVALUATION (EL-39)

From a given set of prints, the student will accurately calculate the total connected motor, welder and heat load to determine the correct branch circuit wire size for each.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

b. Welder branch circuit and feeder calculations
c. Heater branch circuit and feeder calculations
d. Selection of branch circuit and feeder wire size

## TASK

EL-40 Calculating the 120 and 277 volt lighting load

## PERFORMANCE OBJECTIVE

Calculate the 120 and 277 volt lighting load.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Light fixtures
b. Grouping fixtures or branch circuits
c. Arrangement of fixtures (layout)
d. Calculations for lighting loads
e. Selection of fixtures

Provide Demonstration On:

a. Grouping of fixtures on branch circuit
b. Fixture layout
c. Branch circuit calculations

Provide Practical Application On:

a. Laying out the light fixtures
b. Grouping the fixtures on branch circuit
d. Calculating lighting branch circuits

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Manufacturer's catalogs
b. Croft, Carr and Watt, American Electrician Handbook
c. Graham, Industrial and Commercial Wiring
d. Summers, National Electrical Code

A/Vs:

Hobar, "Wiring a Switch and Lamp," slide/tape

Tools and Equipment:

a. Set of prints
b. NEC
c. Fixture catalog
d. Fixture specifications
e. Scale

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (EL-40)

From a given set of prints, the student will accurately complete the necessary calculations to determine the number and type of lighting fixtures needed for proper amount of light.

## TASK

EL-41 Calculating and selecting receptacles for 120/208 volt loads

## PERFORMANCE OBJECTIVE

Calculate and select receptacles for 120/208 volt loads.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. NEMA standards
b. Receptacles (voltage and current rating)
c. Wire selection and ampacities
d. Conduit selection
e. Load calculations

Provide Demonstration On:

a. Receptacles selection
b. Load calculations
c. Branch circuit overcurrent selection

Provide Practical Application On:

a. Branch circuit load calculations
b. Grouping of outlets on branch circuits
c. Branch circuit overcurrent selections
d. Locating conduit runs
e. Determining number of conductors per conduit
f. Branch circuit wire size selection

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Graham, Industrial and Commercial Wiring
b. Summers, National Electrical Code

Tools and Equipment:

a. NEMA device configurations
b. NEC
c. Prints

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (EL-41)

From a given set of prints, the student will accurately calculate the 120/208 volt receptacles outlet load, group the outlets onto branch circuits, select the correct wire, select the proper overcurrent for each branch circuit, select the proper size of conduit and show conduit runs on prints. Work must conform to NEMA standards.

## TASK

EL-42 Calculating size for and selecting and installing a Bass-Duct

## PERFORMANCE OBJECTIVE

Calculate size for and select and install a Bass-Duct.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Buss-Duct system
b. Motor loads
c. Buss-Duct selection
d. Buss-Duct installation
e. Buss-Duct operation
f. Branch circuit selection

Provide Demonstration On:

a. Motor load calculation
b. Buss-Duct selection
c. Buss-Duct installation

Provide Practical Application On:

a. Buss-Duct selection
b. Buss-Duct installation
c. Buss-Duct protection
d. Buss-Duct branch circuits
e. Buss-Duct operation

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Manufacturer's catalog
b. Croft, Carr and Watt, American Electrician Handbook
c. Graham, Industrial and Commercial Wiring
d. Summers, National Electrical Code

Tools and Equipment:

a. Set of prints
b. Motor FLA
c. NEC
d. Required shop tools

LAB HOURS 5

CLASS HOURS 5

## EVALUATION (EL-42)

From a given set of prints showing motor layout, motor voltage and current rating, the student will accurately calculate the total connected motor load. The student will select the correct size Bass-Duct overcurrent protection and branch circuit overcurrent protection for each motor. The student will install a 10 foot length of Bass-Duct.

## TASK

EL-43 Selecting and installing a three phase, four wire 480v panel

## PERFORMANCE OBJECTIVE

Select and install a three phase, four wire 480v panel.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Transformer outputs
b. Transformer hook-ups
c. Types of panels
d. Wire ampacities
e. Conduit types and sizes
f. Bus bar length
g. Panel installation

Provide Demonstration On:

a. Transformer hook-ups
b. Transformer outputs
c. Panel installation and hook-ups

Provide Practical Application On:

a. Transformers
b. Panel installation and hook-ups

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Adams, Electrical Principles and Practices
b. Croft, Carr and Watt, American Electrician Handbook
c. Hubert, Operational Electricity
d. Summers, National Electrical Code

A/Vs:

Hobar, "Electrical Connections and Current Control," filmstrip

Tools and Equipment:

a. Catalog
b. NEC
c. Required shop tools
d. Test equipment
e. Set of prints

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (EL-43)

From a given set of points or load, the student will accurately complete the necessary calculations to determine the appropriate size and type of 480v three phase, four wire panel. The student will select, install and correct to the proper power supply in phase sequence A, B, C and operate a three phase branch circuit from the panel.

## TASK

EL-44 Selecting the correct transformer bank

## PERFORMANCE OBJECTIVE

Select the correct transformer bank.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Transformer selection application
b. Installation
c. Load calculations
d. Panel selection
e. Wire size and type
f. Conduit selection
g. Service grounding
h. Grounding wire size selection
i. Length of panel bus bars

Provide Demonstration On:

a. Transformer selection
b. Load calculations
c. Panel bus bar length

Provide Practical Application On:

Transformer installation and hook-up

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Summers, National Electrical Code
b. Manufacturer's catalog

Tools and Equipment:

a. Set of prints with loads
b. NEC

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 4 |

## EVALUATION (EL-44)

The student will accurately complete the necessary calculations to determine the correct KVA size transformer bank to supply a small industrial facility. The student will make the proper wiring connection and operate the transformer bank 480/277-208/120. Work must meet NEC specifications.

## TASK

EL-45 Selecting and installing a 480v/208-120 three phase four wire service

## PERFORMANCE OBJECTIVE

Select and install a 480v/208-120 three phase four wire service.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. One phase transformer bank
b. Three phase transformers
c. KVA rating
d. Panels
e. Circuit breaker selection and installation

Provide Practical Application On:

a. Making a transformer hook-up (480v/277v three-phase four wire panel installation)
b. Installing circuit breakers (three pole, two pole one pole)
c. Installing branch circuits from panels
d. Making a panel and service grounding

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Croft, Carr and Watt, American Electrician Handbook
b. Supply catalogs

Student Manuals:

Georgia, Industrial Electricity, Industrial Wiring, Unit IW-6

Tools and Equipment:

a. Shop tools
b. Set of prints
c. Catalog
d. Panels
e. Circuit breakers
f. Meter VOM

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## **EVALUATION** (EL-45)

From a given set of prints, the student will accurately calculate the load for a small industrial facility. The student will select the proper transformer bank and select, install and operate the service entrance panels 480v/277-208/120v three phase four wire. The student will install the circuit breakers in these panels for any loads that may be fed from the panels. Work must conform to NEC standards.

## TASK

EL-46 Installing metering equipment

## PERFORMANCE OBJECTIVE

Install metering equipment.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Local and NEC codes
b. Equipment selection
c. Equipment installation
d. Utility company requirement for this class electrical service

Provide Demonstration On:

Procedures for installing meter base

Provide Practical Application On:

a. Installing three phase four wire series metering equipment
b. Installing CT's

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Summers, National Electrical Code
b. Croft, Carr and Watt, American Electrician Handbook
c. Hubert, Operational Electricity
d. Local codes

Student Manuals:

Georgia, Industrial Electricity, Industrial Wiring, Units IW-6 and IW-7

Tools and Equipment:

a. Shop tools
b. Set of prints
c. NEC
d. Local codes

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (EL-46)

From a given set of prints, the student will accurately complete the necessary calculations to determine service size and

1. Select and install the service metering equipment for a three phase four wire 200 amp service
2. Select and install the service metering equipment for a three phase four wire 300 amp service

All work must meet local and NEC standards.

## TASK

EL-47 Selecting and installing panels and selecting distribution equipment

## PERFORMANCE OBJECTIVE

Select and install panels and select distribution equipment.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Subfeeders
b. Types of panels
c. Distribution equipment
d. Subfeeders and selection
e. Cable trays
f. Gutters
g. Raceways
h. Duct system
i. Junction boxes
j. Phase rotation

Provide Demonstration On:

Phase rotation procedure

Provide Practical Application On:

a. Selecting, installing and distributing equipment
b. Selecting and installing sub-panels
c. Installing
    1. Cable trays
    2. Gutters
    3. Raceways
    4. Duct systems
    5. Junction boxes

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Summers, National Electrical Code
b. Adams, Electrical Principles and Practices
c. Hubert, Operational Electricity
d. Manufacturer's catalogs

Student Manuals:

Georgia, Industrial Electricity, Industrial Wiring, Unit IW-12

Tools and Equipment:

a. Equipment catalog
b. NEC
c. Set of prints
d. Shop tools
e. Phase rotation tester

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## **EVALUATION** (EL-47)

From a given set of prints, the student will accurately complete the necessary calculations to determine the type and size of distribution equipment. The student will select and install the correct raceway system, subfeeders and panels. Work must meet electrical code standards.

## TASK

EL-48 Selecting and installing a 277v fluorescent light

## PERFORMANCE OBJECTIVE

Select and install a 277v fluorescent light.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Light output
b. Light selection
c. Placement of light
d. Operation of fluorescent light

Provide Demonstration On:

a. Calculating lighting requirements
b. Procedures for installing fluorescent light

Provide Practical Application On:

a. Calculating light output
b. Installing light

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Croft, Carr and Watt, American Electrician Handbook
b. Graham, Industrial and Commercial Wiring
c. Fixture catalog

A/Vs:

Bergwall, "Finishing the Installation," filmstrip/tape; "Low Voltage and Special Circuits," filmstrip/tape

Student Manuals:

Georgia, Industrial Electricity, Industrial Wiring, Unti IW-13

Tools and Equipment:

a. Shop tools
b. 277v fluorescent light
c. Set of prints

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 3 |

**EVALUATION** (EL-48)

From a given set of prints, the student will accurately determine the number of fluorescent lights needed to provide adequate light, select the type needed, show placement of the fixtures, arrange the lights onto branch circuits, install a 277v fluorescent light fixture, make wiring connections and operate the light. The installation should meet all code requirements.

## TASK

EL-49 Determining sizes and types of feeders and overcurrent protection devices

## PERFORMANCE OBJECTIVE

Determine sizes and types of feeders and overcurrent protection devices.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Feeder selection
b. Overcurrent protection selection
c. Motor nameplate

Provide Demonstration On:

Feeder calculations and selections

Provide Practical Application On:

a. Selecting feeder circuit conductors
b. Selecting feeder overcurrent protection device

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Summers, National Electrical Code
b. Croft, Carr and Watt, American Electrician Handbook

A/Vs:

Hobar Publications, "Electrical Connections and Current Control," slide/tape

Student Manuals:

Georgia, Industrial Electricity, Industrial Wiring, Unit IW-16

Tools and Equipment:

a. Prints
b. NEC

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (EL-49)

From a given set of prints, the student will accurately complete the necessary calculations to determine the correct size and type of feeder and overcurrent protective device for a group of 480v three phase motors. Determinations should be accurate and agree with local code requirements.

## TASK

EL-50 Installing a branch circuit for welders

## PERFORMANCE OBJECTIVE

Install a branch circuit for welders.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Welder nameplate
b. Welder operation

Provide Demonstration On:

a. Welder branch circuit
b. Welder calculation

Provide Practical Application On:

a. Welder branch circuits
b. Feeder selections and installations

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Croft, Carr and Watt, American Electrician Handbook
b. Van Vaulkenburgh, Basic Industrial Electricity
c. Summers, National Electrical Code

Student Manuals:

Georgia, Industrial Electricity, Industrial Wiring, Unit IW-19

Tools and Equipment:

a. Shop tools
b. Set of prints

| | |
|---|---|
| LAB HOURS | 6 |
| CLASS HOURS | 4 |

## EVALUATION (EL-50)

From a given set of prints, the student will accurately complete the necessary calculations to determine the proper size branch conductors and overcurrent protection for transformer arc welders and resistance welders. All work must meet the NEC requirements.

## TASK

EL-51 Operating a split phase motor

## PERFORMANCE OBJECTIVE

Operate a split phase motor.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Motor operation and winding
b. Motor nameplate
c. Load characteristics
d. Torque characteristics
e. Dual volts motors
f. Efficiency
g. Applications

Provide Demonstration On:

a. Direction of rotation of single phase motor
b. Load characteristics of a split phase motor
c. Torque characteristics of split phase motor
d. Applications of split phase motors

Provide Practical Application On:

a. Direction of rotation of single phase motor
b. Load characteristics of a split phase motor
c. Torque characteristics of split phase motor
d. Applications of split phase motors

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Veinott, Fractional and Subfractional Horsepower Electric Motors
b. Rosenberg, Electric Motor Repair
c. Croft, Carr and Watt, American Electrician Handbook

A/Vs:

AAVIM, "How Electric Motors Start and Run," slide/tape

Student Manuals:

Georgia, Industrial Electricity, Industrial Wiring, Unit IW-20

Tools and Equipment:

a. Shop tools
b. Meters AC volt-amp-watt
c. Motor and equipment
d. Motor standards
e. Power supply
f. Motor loads

| | |
|---|---|
| LAB HOURS | 4 |
| CLASS HOURS | 4 |

## EVALUATION (EL-51)

Given a split phase motor, the necessary test equipment and power supply, the student will accurately operate and check the following motor characteristics: torque, start amps, full load amps, speed and efficiency. NEMA standards should be used for comparisons.

## TASK

EL-52 Operating a capacitor start motor

## PERFORMANCE OBJECTIVE

Operate a capacitor start motor.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Motor capacitor
b. Motor nameplate
c. Motor operation and winding
d. Torque characteristics
e. Load characteristics

Provide Demonstration On:

How to operate, hook-up and calculate the load characteristics of capacitor motors

Provide Practical Application On:

a. Determining starting characteristics of a capacitor start motor
b. Determining load characteristics of a capacitor motor
c. Determining torque characteristics of a capacitor

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Veinott, Fractional and Subfractional Horsepower Electric Motors
b. Rosenberg, Electric Motor Repair
c. Croft, Carr and Watt, American Electrician Handbook

A/Vs:

AAVIM, "How Electric Motors Start and Run," slide/tape

Student Manuals:

Georgia, Industrial Electricity, Industrial Wiring, Unit IW-22

Tools and Equipment:

a. Shop tools
b. Meters AC volt-amp-watt
c. Motor and equipment
d. Motor standards
e. Power supply
f. Motor loads

| | |
|---|---|
| LAB HOURS | 4 |
| CLASS HOURS | 4 |

**EVALUATION** (EL-52)

Given a capacitor start motor and the necessary test equipment and power supplies, the student will accurately operate and check the following motor characteristics: torque, start amps, full load amps, speed and efficiency. Use NEMA standards for comparison.

## TASK

EL-53 Operating a universal motor

## PERFORMANCE OBJECTIVE

Operate a universal motor.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Universal motor
b. Motor nameplate
c. AC operation
d. DC operation
e. Forward/reverse operation
f. Load characteristic
g. Speed control
h. Applications
i. Motor efficiency AC/DC

Provide Demonstration On:

Hooking up, operating and checking the characteristics of a universal motor

Provide Practical Application On:

a. Forward/reverse operation of motor
b. Speed control
c. DC operation of motor
d. AC operation of motor

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Veinott, Fractional and Subfractional Horsepower Electric Motors
b. Rosenberg, Electric Motor Repair
c. Adams, Electrical Principles and Practices

A/Vs:

AAVIM, "How Electric Motors Start and Run," slide/tape

Student Manuals:

Georgia, Industrial Electricity, Industrial Wiring, Unit IW-25

Tools and Equipment:

a. Shop tools
b. Meters AC and DC volt-amp-watt
c. Motor and equipment
d. Motor standards
e. Power supplies AC and DC
f. Motor loads

LAB HOURS 4

CLASS HOURS 4

## EVALUATION (EL-53)

Given a universal motor, necessary test equipment and AC/DC power supplies, the student will accurately hook-up, operate and check the following motor characteristics: torque, start amps, full load amps, speed and efficiency. Use NEMA standards for comparison.

## TASK

EL-54 Operating a three phase induction motor

## PERFORMANCE OBJECTIVE

Operate a three phase induction motor.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Motor nameplate information
b. Three phase induction motor
c. Three phase power
d. Forward and reverse operation
e. Load characteristic
f. Start characteristic
g. Run characteristic
h. Motor efficiency
i. Applications

Provide Practical Application On:

a. Forward/reverse operation
b. Applications
c. Dual volts motors
d. Starting characteristic and direction of rotation
e. Torque characteristic of three phase induction motors
f. Load characteristics of three phase induction motors
g. Efficiency of a three phase induction motor

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Veinott, Fractional and Subfractional Horsepower Electric Motors
b. Rosenberg, Electric Motor Repair
c. Adams, Electrical Principles and Practices

A/Vs:

AAVIM, "How Electric Motors Start and Run," slide/tape

Student Manuals:

Georgia, Industrial Electricity, Industrial Wiring, Unit IW-27

Tools and Equipment:

a. Shop tools
b. Motor and equipment
c. Meters AC volt, amp, watt
d. Motor standards
e. Power supply
f. Motor load

**LAB HOURS** 4

**CLASS HOURS** 4

## EVALUATION (EL-54)

Given a three phase induction motor, the necessary test equipment and power supply, the student will accurately hook-up, operate and check the following motor characteristics: torque, start amps, full load amps, speed and efficiency. Use NEMA standards for comparison.

## TASK

EL-55 Operating a three phase synchronous motor

## PERFORMANCE OBJECTIVE

Operate a three phase synchronous motor.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Three phase synchronous motor
b. Speed control
c. Motor nameplate
d. Motor operation
e. Motor load characteristics
f. Motor start characteristics
g. Motor efficiency
h. Motor applications

Provide Demonstration On:

How to hook-up, operate and check the characteristics of a three phase induction motor

Provide Practical Application On:

a. Speed control
b. Motor operation
c. Motor start, run, torque
d. Characteristics

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Adams, Electrical Principles and Practices
b. Croft, Carr and Watt, American Electrician Handbook

A/Vs:

AAVIM, "How Electric Motors Start and Run,: slide/tape

Student Manuals:

Georgia, Industrial Electricity, Industrial Wiring, Unit IW-29

Tools and Equipment:

a. Shop tools
b. Motor and equipment
c. Meters AC, volt-amp-watt
d. Motor standards
e. Power supply
f. Motor load

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (EL-55)

Given a three phase synchronous motor, necessary test equipment and power supply, the student will accurately hook-up, operate and check the following motor characteristics: torque, start amps, full load amps, speed and efficiency. Use NEMA standards for comparison.

## TASK

EL-56 Operating a three phase, one winding, two speed motor

## PERFORMANCE OBJECTIVE

Operate a three phase, one winding, two speed meter.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Motor nameplate
b. Motor windings
c. Motor winding connections
d. Motor RPM
e. Motor connection to the line
f. Motor operation at each speed
g. Motor horsepower
h. Motor torque

Provide Demonstration On:

a. Demonstrating motor magnetic pole relationships
b. Making motor winding identification
c. Making motor lead connection

Provide Practical Application On:

a. Motor winding identification
b. Motor lead identification
c. Motor lead connection
d. Motor connection to line
e. Direction of rotation
f. Motor operation low and high speed

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Hubert, Operational Electricity
b. Siskind, Electrical Circuits
c. Rosenberg, Electric Motor Repair
d. Siskind, Electrical Control Systems in Industry

A/Vs:

AAVIM, "How Electric Motors Start and Run," slide/tape

Student Manuals:

Georgia, Industrial Electricity, Industrial Wiring, Unit IW-30

Tools and Equipment:

a. Shop tools
b. Motor three phase, one winding, two speed
c. Test meter (VOM)
d. AC amp-meter

(Continued on back)

| | |
|---|---|
| LAB HOURS | 4 |
| CLASS HOURS | 4 |

## EVALUATION (EL-56)

Given a one winding, two speed, three phase motor, necessary test equipment and power supply, the student will accurately hook-up, operate and check the following characteristics: torque, horsepower, start amps, full load amps, speed and efficiency.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

e. Power supply
f. Motor loads
g. Strobotach

## TASK

EL-57 Operating a three phase, two winding, two speed motor

## PERFORMANCE OBJECTIVE

Operate a three phase, two winding, two speed motor.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Motor nameplate
b. Motor windings
c. Motor connections (windings)
d. Motor RPM
e. Motor connection to line
f. Motor operation on each winding
g. Motor horsepower
h. Motor torque

Provide Demonstration On:

a. Demonstrating motor pole relationships
b. Making motor winding identification

Provide Practical Application On:

a. Motor winding identification
b. Motor leads identification
c. Motor connection to line
d. Direction of rotation
e. Motor operation low and high speed

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Hubert, Operational Electricity
b. Siskind, Electrical Circuits
c. Rosenberg, Electric Motor Repair
d. Siskind, Electrical Control Systems in Industry

A/Vs:

AAVIM, "How Electric Motors Start and Run," slide/tape

Student Manuals:

Georgia, Industrial Electricity, Industrial Wiring, Unit IW-31

Tools and Equipment:

a. Shop tools
b. Motor three phase two winding, two speed
c. Test meter (VOM)
d. AC amp-meter

(Continued on back)

| | |
|---|---|
| LAB HOURS | 4 |
| CLASS HOURS | 4 |

## EVALUATION (EL-57)

Given a two winding two speed three phase motor, necessary test equipment and power supplies, the student will accurately hook-up, operate and check the following characteristics: torque, horsepower, start amps, full load amps, speed and efficiency. Use NEMA standards for comparison.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

e. Power supply
f. Motor load
g. Strobotach

387

## TASK

EL-58 Operating single and three phase alternators

## PERFORMANCE OBJECTIVE

Operate single and three phase alternators.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Alternators above and below rated speed
b. Alternators above and below rated volts
c. Alternators operating at unity power factor
d. Alternators operating at lapping power factor
e. Alternators operating at leading voltage factor
f. Voltage regulation of alternators

Provide Demonstration On:

Hooking up and performing load tests on alternators

Provide Practical Application On:

a. Operating alternators above and below rated speed
b. Operating alternators above and below rated volts
c. Operating alternators at unity power factor
d. Operating alternators at lagging power factor
e. Operating alternators at leading power factor
f. Voltage regulation of alternators

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Adams, *Electrical Principles and Practices*
b. Timble and Willson, *Industrial Electricity*
c. Siskind, *Electrical Circuits*
d. Duff, *Alternating Current Fundamentals*
e. Siskind, *Electrical Control Systems in Industry*

Tools and Equipment:

a. Shop tools
b. Alternator
c. Motors AC and DC
d. Meter "VOM"
e. DC amp meter
f. AC amp meter
g. Loads for alternator
h. Power supplies AC and DC

(Continued on back)

LAB HOURS 4
CLASS HOURS 4

## EVALUATION (EL-58)

Given a single and a three phase alternator, necessary test equipment, power supplies, loading equipment and rotating machinery, the student will accurately hook-up, operate and perform the following load test on the alternators:

1. Above and below rated speed
2. Above and below rated volts
3. Test the alternators' lagging, leading and unity power factor
4. Demonstrate voltage regulations of alternators
5. Record the data from each test
6. Hook-up and operate a 254v 1 phase alternator
7. Hook-up and operate a 508v 1 phase alternator
8. Hook-up and operate a 220/440v 3 wire 1 phase alternator
9. Hook-up and operate a 122v 2 parallel Delta alternator
10. Hook-up and operate a 220v 2 parallel Wye alternator
11. Hook-up and operate a 254v series Delta alterantor
12. Hook-up and operate a 44v series Wye alternator
13. Hook-up and operate a 380v interconnected Wye alternator
14. Hook-up and operate a 127v double Delta alternator
15. Hook-up and operate a 127v parallel diametrical alternator
16. Hook-up and operate a 254v series diametrical alternator

## INSTRUCTIONAL MATERIALS

Student Manuals:

a. Standard Electric Time Bulletin
b. Georgia, Industrial Electricity: Industrial Wiring, Unit IW-41

## TASK

EL-59 Operating an induction regulator

## PERFORMANCE OBJECTIVE

Operate an induction regulator.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Induction regulator
b. Transformers

Provide Demonstration On:

Making connections for and operating a three phase induction regulator

Provide Practical Application On:

a. Induction regulator
b. Volts-output
c. Amp-output
d. Load capability

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Van Volkenburgh, Nooger and Neville, Basic Industrial Electricity
b. Siskind, Electrical Circuits
c. Penden and Del Mar, Electrical Engineer's Handbook
d. Siskind, Electrical Control Systems in Industry

(Continued on back)

Tools and Equipment:

a. Motor generator set
b. Shop tools
c. Meters (VOM)
d. AC amp-meter
e. Power supply

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 5 |

## EVALUATION (EL-59)

Given the required machinery control equipment and components, necessary test equipment and power supplies, the student will accurately make the wiring connections and operate the three-phase induction regulator at 220-440 volts. The load may be resistive or inductive.

INSTRUCTIONAL MATERIALS

Student Manuals:

a. Standard Electric Time Bulletin
b. Georgia, Industial Electricity: Industrial Wiring, Unit IW-41

## TASK

EL-60 Operating a rotary frequency changer

## PERFORMANCE OBJECTIVE

Operate a rotary frequency changer.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Frequency changers
b. Driven with synchronous field
c. Driven against synchronous field
d. RPM of frequency changers

Provide Demonstration On:

Making wiring connections for and operating a frequency changer

Provide Practical Application On:

a. Operating frequency changers
b. Operating synchronous field
c. Operating against synchronous field
d. Rotation of frequency changer
e. RPM of frequency changer
f. Motor driver

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Croft, Carr and Watt, American Electrician's Handbook
b. Siskind, Electrical Circuits; Electrical Control Systems in Industry

Student Manuals:

a. Standard Electric Time Bulletin
b. Georgia, Industrial Electricity, Industrial Wiring, Unit IW-42

Tools and Equipment:

a. Motor/generator set
b. Shop tools
c. Meters VOM, frequency counter
d. Power supply

| | |
|---|---|
| LAB HOURS | 4 |
| CLASS HOURS | 4 |

## EVALUATION (EL-60)

Given the required machinery, control components, necessary test equipment and power supplies, the student will accurately make the wiring connections and operate the three phase frequency changer with rotor driven synchronous field rotation 0-60 cycles - 220 volts. The student will operate the three phase frequency changer driven against synchronous field rotation of 60-120 cycles 215-440 volts.

## TASK

EL-61 Operating a synchronous rotary converter

## PERFORMANCE OBJECTIVE

Operating a synchronous rotary converter.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Rotary converter
b. Operation of synchronous rotary converters
c. Converting AC to DC
d. Phasing

Provide Demonstration On:

How to convert AC to DC

Provide Practical Application On:

a. Operating synchronous rotary converters
b. Converting AC to DC

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Timble and Willson, Industrial Electricity
b. Croft, Carr and Watt, American Electrician Handbook

Student Manauls:

a. Standard Electric Time Bulletin
b. Georgia, Industrial Electricity, Industrial Wiring, Unit IW-43

Tools and Equipment:

a. Motor/generator
b. Shop tools
c. Meter VOM
d. Loads
e. Power supply
f. DC amp meter

| | |
|---|---|
| LAB HOURS | 4 |
| CLASS HOURS | 4 |

## EVALUATION (EL-61)

Given the required machinery, control components and the necessary test equipment and power supplies, the student will accurately make the wiring connections and operate a synchronous rotary converter (AC to DC) self excited. The student will test the converter using a 125 volt 2.5 ampere resistor load.

## TASK

EL-62 Operating a rotary converter

## PERFORMANCE OBJECTIVE

Operating a rotary converter.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Rotary converters
b. Operation of rotary converters
c. Converting DC to AC

Provide Demonstration On:

Converting DC to AC

Provide Practical Application On:

a. Operating a rotary converter
b. Converting AC to DC

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Penden and Del Mar, Electricial Engineer's Handbook
b. Siskind, Electrical Circuits; Electrical Control Systems in Industry

A/Vs:

Bergwall, "Rotary Machinery Explained - Direct Current Motors," filmstrip/tape

Student Manuals:

a. Standard Electric Time Bulletin
b. Georgia, Industrial Electricity, Industrial Wiring, Unit IW-44

Tools and Equipment:

a. Motor/generator
b. Shop tools
c. Meter VOM
d. Load

(Continued on back)

| | |
|---|---|
| LAB HOURS | 4 |
| CLASS HOURS | 4 |

## EVALUATION (EL-62)

Given the required machinery and control components, the student will accurately make the wiring connections and operate a rotary converter (DC to AC). The student will test the rotary converter with a 7 amp load at 70 volts three phase.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

e. Amp-meter AC
f. Power supply

## TASK

EL-63 Operating DC motors

## PERFORMANCE OBJECTIVE

Operate DC motors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Series DC motors
b. Shunt DC motors
c. Compound DC motors
d. Load characteristic of each
e. Speed characteristics of each
f. Torque characteristics of each
g. Start amps of each
h. Full load amps of each
i. Speed and efficiency of each
j. Forward and reverse of each
k. Application of each

Provide Demonstration On:

a. Series windings of DC motors
b. Shunt wound DC motors
c. Compound wound DC motors

Provide Practical Application On:

a. Operating series DC motors
b. Operating shunt DC motors
c. Operating compound DC motors

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Timbel and Willson, Industrial Electricity
b. Rosenberg, Electric Motor Repair
c. Croft, Carr and Watt, American Electrician Handbook
d. Duff, Alternating Current Fundamentals

A/Vs:

Bergwall, "Rotary Machinery Explained - Direct Current Motors," filmstrip/tape

Student Manuals:

a. Standard Electric Time Bulletin
d. Georgia, Industrial Electricity, Industrial Wiring, Units IW-45, IW-46 and IW-47

Tools and Equipment:

a. Shop tools
b. Series DC motor

(Continued on back)

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|---|---|
| LAB HOURS | 4 |
| CLASS HOURS | 4 |

## EVALUATION (EL-63)

Given the required rotating machinery and control components, necessary test equipment and power supplies, the student will accurately hook-up and operate series, shunt and compound wound DC motors. The student will determine the following characteristics of the motor: torque, start amps, full loads amps, speed and efficiency. The student will make a comparison of these three DC motors.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

c. Shunt DC motor
d. Compound DC motor
e. Loads for motors
f. Power supply
g. Meter VOM

## TASK

EL-64 Operating and checking load characteristics of DC generators

## PERFORMANCE OBJECTIVE

Operate and check load characteristics of DC generators.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. DC generators
   1. Series
   2. Shunt
   3. Compound
b. Compound
c. Operation and hook-up
d. Voltage and current capabilities
e. Rotation
f. RPM
g. Driver

Provide Demonstration On:

How to hook-up and test series, shunt and compound generators

Provide Practical Application On:

a. Hooking up and operating series generators
b. Hooking up and operating shunt generators
c. Hooking up and operating compound generators
d. Volt amp output of each generator
e. Types of load for each generator

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Duff, Alternating Current Fundamentals
b. Adams, Electrical Principles and Practices

Student Manuals:
a. Standard Electric Time Bulletin
b. Georgia, Industrial Electricity, Industrial Wiring, Units IW-48, IW-49 and IW-50

Tools and Equipment:

a. Shop tools
b. Motor generator set
c. Meter VOM
d. DC amp meter
e. Resistive load
f. Inductive load
g. Power supply

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

**EVALUATION** (EL-64)

Given the required rotating machinery and control components, the necessary test equipment and power supplies, the student will accurately hook-up, operate and test series, shunt and compound generator for maximum output with the proper load (resistive or inductive).

## TASK

EL-65 Correcting power factors

## PERFORMANCE OBJECTIVE

Correct power factors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Power factor
b. Power factor improvement
c. Inductance
d. Capacitance
e. Reactance

Provide Demonstration On:

Power factor calculation techniques

Provide Practical Application On:

Power factor correction

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Croft, Carr and Watt, American Electrician Handbook
b. Adams, Electrical Principles and Practices

Student Manuals:

Georgia, Industrial Electricity, Industrial Wiring, Unit IW-51

Tools and Equipment:

a. Shop tools
b. Assorted run capacitor
c. Meters VOM
d. Motor
e. AC-amp-meter
f. Watt meter
g. Power supply

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

**EVALUATION** (EL-65)

Given a single phase 115v induction motor with a low power factor, the necessary test equipment and power supplies, the student will accurately complete the necessary calculations to determine the correct microfarad of a capacitor to improve the motor power factor by 85%. The student will install the capacitor, operate the motor and complete the following test: start amps, run amps, torque and speed.

## TASK

EL-66 Hooking up and operating gear motors

## PERFORMANCE OBJECTIVE

Hook-up and operate gear motors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Motor
b. Reduction gears
c. Gear drives
d. Belt drives
e. Speed ratio
f. Variable speed drives

Provide Demonstration On:

Hooking up and operating belt and gear driven motors

Provide Practical Application On:

a. Operating gear drives
b. Operating belt drives
c. Operating gear motors

## INSTRUCTIONAL MATERIALS

Textbooks:

Croft, Carr and Watt, American Electrician Handbook

Student Manuals:

Georgia, Industrial Electricity, Industrial Wiring, Unit IW-52

Tools and Equipment:

a. Shop tools
b. Gear motors drives
c. Power supply
d. Meter VOM
e. AC amp meter

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (EL-66)

Given a variable speed belt driven gear drive and a variable speed reduction gear drive, along with the necessary test equipment and control components, the student will make the required electrical and mechanical connections and operate each drive through a full speed range.

## TASK

EL-67 Selecting correct machine drive

## PERFORMANCE OBJECTIVE

Select correct machine drive.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Motors
b. Drive couplings
c. Ratio of pulleys
d. Speeds of machine drives
e. Shaft sizes

Provide Demonstration On:

Techniques for selecting proper motor drive

Provide Practical Application On:

a. Belt drives
b. Chain drives
c. Direct drives

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Croft, Carr and Watt, *American Electrician Handbook*
b. AAVIM, *Electric Motor Drives*

Student Manuals:

Georgia, *Industrial Electricity, Industrial Wiring*, Unit IW-53

Tools and Equipment:

a. Shop tools
b. Motor
c. Pulleys
d. Sprockets
e. Shafts
f. Meter VOM

(Continued on back)

**LAB HOURS** 5

**CLASS HOURS** 5

**EVALUATION** (EL-67)

Given a machine drive application, the student will complete the necessary calculations to determine the correct motor drive method. The student will select the motor to be installed and specify hp, volts and rpm for coupling the motor to drive. All materials and equipment must meet manufacturer's installation recommendations.

## TASK

EL-68 Installing ventilator fans

## PERFORMANCE OBJECTIVE

Install ventilator fans.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Motors
b. Fans
c. Ventilation
d. CFM
e. Cubic measure
f. Fan control

Provide Demonstration On:

a. How to install controls for a ventilator fan
b. Determining ventilating requirements
c. Selecting motors to drive fans

Provide Practical Application On:

a. Motor types and installation
b. Fan location
c. Fan drives
d. Control of fans

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Croft, Carr and Watt, *American Electrician Handbook*
b. AAVIM, *Electric Motors*
c. Althouse, Turnquist and Bracciano, *Modern Refrigeration and Air Conditioning*

Student Manuals:

Georgia, *Industrial Electricity, Industrial Wiring*, Units IW-54 and IW-56

Tools and Equipment:

a. Shop tools
b. Fan specs
c. CFM specs
d. Strobotach
e. Power supply
f. Print

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

**EVALUATION** (EL-68)

Given the requirements for a small building in terms of CFM air removal and the necessary test equipment and material, the student will accurately select and install the controls for the correct size and type ventilator fan. All work must meet local and national code standards.

## TASK

EL-69 Identifying motor leads

## PERFORMANCE OBJECTIVE

Identify motor leads.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Motors
b. Each motor winding type
c. Lead identification
d. Lead marking procedure
e. Lead connection of each
f. Line connection of each
g. Motor voltage of each

Provide Demonstration On:

a. Motor winding types
b. Single volts motors
c. Dual volts motor
d. Three phase dual volts motor

Provide Practical Application On:

a. Lead identification of single phase motors
b. Lead identification of three phase motors

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Rosenberg, Electric Motor Repair
b. Veinott, Fractional and Subfractional Horsepower Electric Motors

Student Manuals:

Georgia, Industrial Electricity, Industrial Wiring, Units IW-57, IW-58, IW-59 and IW-60

Tools and Equipment:

a. Shop tools
b. Power supplies
c. Meter VOM
d. AC amp meter
e. Power supplies

(Continued on back)

**LAB HOURS** 4

**CLASS HOURS** 4

## EVALUATION (EL-69)

Given a single phase induction motor with four unmarked leads, a single phase induction motor with six unmarked leads and three phase Wye or Delta wound induction motor with nine unmarked leads, necessary test equipment and power supplies, the student will correctly identify the leads of each motor and make the correct motor lead connection. Wiring connections to the proper power supply must be accurate. The student will operate the motor and check for proper rpm.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

f. One phase single volts motor
g. One phase dual volt motor
h. Three phase Delta wound motor
i. Three phase Wye wound motor
j. Strobotach

## TASK

EL-70 Identifying hazardous wiring locations

## PERFORMANCE OBJECTIVE

Identify hazardous wiring locations.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Hazardous locations
b. Wiring methods
c. Sealing conduits

Provide Demonstration On:

Special techniques for installing wiring in hazardous locations

Provide Practical Application On:

Installing wiring under simulated hazardous conditions

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Croft, Carr and Watt, *American Electrician Handbook*
b. Summers, *National Electric Code*

A/Vs:

Career Aids, Inc., "Electrical Safety in the Shop," filmstrip/tape

Student Manuals:

Georgia, *Industrial Electricity, Industrial Wiring*, Unit IW-61

Tools and Equipment:

a. NEC
b. Shop tools
c. Set of prints
d. Materials catalog

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|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 4 |

**EVALUATION** (EL-70)

Given a complete set or prints for a gasoline dispensing station with a grease pit, the student will accurately classify each area of the unit as to class location and specify the wiring method to be installed. The student will select the material to be installed and installation must be in accordance with local and national code standards.

## TASK

EL-71 Operating a power actuated tool

## PERFORMANCE OBJECTIVE

Operate a power actuated tool.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Conduit installation
b. Correct operation of power actuated tools

Provide Demonstration On:

Proper use of a power actuated tool

Provide Practical Application On:

Using a Ramset power actuated tool

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Summers, National Electric Code
b. Manufacturer's operator's manual

Student Manuals:

Georgia, Industrial Electricity, Industrial Wiring, Unit IW-62

Tools and Equipment:

a. Ramset tools
b. Materials
c. Conduit
d. Straps
e. Surface to fasten to

| | |
|---|---|
| LAB HOURS | 4 |
| CLASS HOURS | 4 |

## EVALUATION (EL-71)

Given a power actuated fastening tool and the proper instructions and materials, the student will accurately fasten 1/2" EMT conduit to steel framing and to a masonry wall.

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*Title IX - Evelyn Rowe and Myra Tolbert, Coordinators*
*Section 504 - Jane Lee, Coordinator of Special Education*

*Inquiries concerning the application of Title II, Title VI, Title IX or Section 504 to the policies and practices of the department may be addressed to the persons listed above at the Georgia Department of Education, State Office Building, Atlanta 30334; to the Regional Office for Civil Rights, Atlanta 30323; or to the Director, Office for Civil Rights, Education Department, Washington, D.C. 20201.*